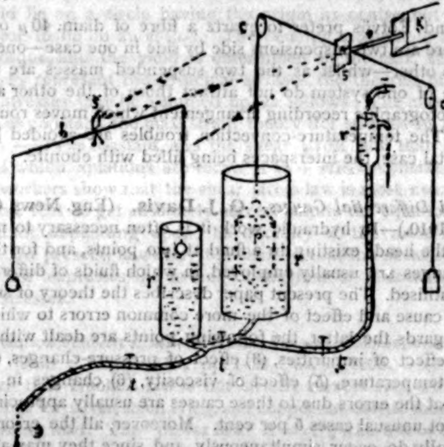
SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1910.

GENERAL PHYSICS.

492. *Apparatus to Demonstrate Elastic Hysteresis.* **L. Tieri.** (N. Cimento, 18. pp. 430–431, Nov.–Dec., 1909.)—The Fig. shows an apparatus by which the elastic hysteresis of a piece of glass rod may be demonstrated. The rod *v* is affixed at one end to a solid support *k*, a small mirror *s* being attached to the other end, to which are also fixed two threads that, passing over two sensitive pulleys, support two weights *p* and *p'*. A balance *b* is placed parallel to the glass rod, a mirror *s'* being attached to its fulcrum, and



suspended from its arms being two small shot, one of which, when the balance is in equilibrium, is half immersed in water in a vessel r'. The vessels r and r' communicate with each other, and with a reservoir r'', in which water is maintained at constant level. The glass rod is first deformed to the left by altering the levels of the water in r and r', and then towards the right, its movements being shown by reflection from the two mirrors of a luminous point on to a screen. W. H. Si.

493. *The Eötvös Torsion Balance.* **O. Hecker.** (Zeitschr. Instrumentenk. 30. pp. 6–14, Jan., 1910.)—Eötvös [see Phys. Soc. Abstracts, No. 4 (1897)] published some account of methods to determine the space variation in the acceleration of gravity. The theory and some developments are mentioned here. Suppose strata of varying density are distributed immediately under the earth's surface, the pendulum will set away from the normal to the surface, and the Cavendish torsion balance, if slowly rotated on the axis of its suspension, will carry the suspension with it; but the azimuth of the beam will differ slightly from that of the head in some directions on account of attraction due to these strata. For one form of apparatus—

$$\theta = \frac{1}{2}\frac{\kappa}{\tau}\left(\frac{\partial^2 U}{\partial y^2} - \frac{\partial^2 U}{\partial x^2}\right)\sin 2\alpha + \frac{\kappa}{\tau}\frac{\partial^2 U}{\partial x \partial y}\cos 2\alpha,$$

where θ = angle of twist, τ = the modulus of torsion of the suspending fibre, κ = the moment of inertia, α = the angle between the beam and the x-axis of co-ordinates, U = gravitation potential. The space variation in gravity—

$$\frac{\partial g}{\partial s} = \sqrt{\left(\frac{\partial^2 U}{\partial x \partial z}\right)^2 + \left(\frac{\partial^2 U}{\partial y \partial z}\right)^2}.$$

The author and Eötvös prefer to quartz a fibre of diam. 40 μ of platinum-iridium. There are two suspensions side by side in one case—one acting as a check on the other—whilst as the two suspended masses are at different heights, those of one system do not attract those of the other appreciably. There is a photographic recording arrangement which moves round with the whole case. The temperature-convection troubles are avoided by having a three-fold metal case, the interspaces being filled with ebonite. P. E. S.

494. *Fluid Differential Gauges.* **G. J. Davis.** (Eng. News, 63. pp. 216–218, Feb. 24, 1910.)—In hydraulic work it is often necessary to measure the difference of the heads existing in a fluid at two points, and for this purpose differential gauges are usually employed, in which fluids of different specific gravities are utilised. The present paper describes the theory of such gauges, and gives the cause and effect of the more common errors to which they are liable. As regards the latter, the following points are dealt with: (1) Error in sp. gr., (2) effect of impurities, (3) effect of pressure-changes, (4) effect of variations in temperature, (5) effect of viscosity, (6) changes in capillarity. It is shown that the errors due to these causes are usually appreciable, reaching in some not unusual cases 5 per cent. Moreover, all the errors discussed may, and usually do, occur simultaneously, and since they may all have the same sign the resulting total error would be large. The errors increase rapidly with the degree of magnification, and hence, in the present state of our knowledge of gauge fluids, it would be prudent to select those giving only a moderate magnification. The author also recommends calibration of each gauge against a water-gauge at the same pressure and temperature, instead of calculating the gauge coefficient, as is usually done, from the specific gravities of the fluids used. A. W.

495. *Ductile Materials under Combined Stresses.* **W. A. Scoble.** (Phil. Mag. 19. pp. 116–128, Jan., 1910. Paper read before the Physical Soc., Nov. 26, 1909.)—The results of previous tests [Abstract No. 6 (1907)] are further considered and later experiments on steel, brass, and copper tubes are described. The test specimens, 36 in. × ½ in. diam. were subjected at one and the same time to a torsion producing a uniform torque along the length, and a bending stress whose maximum was confined to a section near the centre of the specimen, this system of loading representing the most common example of combined stresses met with in engineering practice. The usual practice is to regard the yield-point as the criterion of strength, but in order to have a well-defined point the author has neglected the state between the elastic-limit and yield-point, and taken the intersection of the curves limiting this region as the critical load. If p represents the max. tensile strength due to bending, and s the max. shear stress due to torque, the max. and min. principal stresses are expressed by $p/2 \pm \sqrt{(p^2/4 + s^2)}$, the third principal stress being zero since the shearing stress is zero where the bending stress is at maximum. The stress difference is $2\sqrt{(p^2/4 + s^2)}$, and is twice the max. shear stress, while the max. strain is $[P_1 - \eta(P_2 + P_3)]/E$, where P_1, P_2, and P_3 are principal stresses (P_1 = max. and P_2 min.), η = Poisson's ratio, and E = Young's modulus. Since there are stresses in one plane only, the expression becomes $(P_1 - \eta P_2)/E$. The results are tabulated, and the bending and twisting moments at yield plotted, and the curves for bars and tubes confirm the view that the max. shear stress is approximately constant at failure. If the max. shear stress were absolutely constant, the plotted points would lie on a circle having the origin as centre, but in reality the points appear to lie on an ellipse. The bending moment is always greater than the torque, and the yield is determined by the max. shear stress. If P_1, P_2, and P_3 represent the principal stresses, the theories of failure under combined stresses may be summed up as follows: The max. stress theory assumes P_1 = constant, the max. strain theory (for stresses in two directions) assumes $P_1 - \eta P_2$ = constant, and the shear stress law that $P_1 - P_2$ = constant, all of which equations are forms of $P_1 + mP_2$ = constant. The results of various workers show that the shear stress law is most nearly correct, but it is possible that to get absolutely correct results the equation must contain some constant depending upon the ductility of the material under consideration. At present, however, it is claimed that the shear stress or stress-difference law expresses the average behaviour of ductile materials under combined stresses. F. C. A. H. L.

496. *Relation between Elastic Modulus, Tension, Torsion, and Strain.* **F. A. Schulze.** (Ann. d. Physik, 31. 1. pp. 1–30, Dec. 30, 1909.)—Recent researches have shown that Hooke's law is not strictly correct even within the elastic limit, and that for silver, steel, brass, and copper the elastic modulus decreases with increasing load. The "power law" $X = cP^m$, where X = total elongation under a load P, has been shown to apply only to great extensions. The author has made experiments to determine the elastic modulus by the method of the longitudinal vibration of wires (see Kohlrausch's Lehrbuch d. prakt. Physik), the moduli obtained being termed "adiabatic" to distinguish from those determined by the static method which the author calls "isotherms."

In the tension tests two series of experiments were carried out: one in which the wires were tightly clamped and subjected to extensions λ on both sides of the clamped position, and the other in which the wires were successively loaded with weights, experiments being carried to fracture in each case. The results showed that the adiabatic modulus decreases linearly with the increase of extension $E_\lambda = E_0 - a\lambda$, and decreases with increased loading, as shown by the equation $E_\lambda = E_0 - cp$, c being a constant and p the load. The magnitudes of the decreases are comparable with those found for the static moduli by J. O. Thompson. Within very wide limits, the adiabatic elastic modulus is, in the cases of steel and brass, independent of the torsion, but by overstepping a certain critical torsion the modulus decreases rapidly by about 1 per cent. in the case of steel and increases about 1 per cent. in the case of brass. The adiabatic elastic modulus depends upon the magnitude of the load when the load exceeds the elastic limit, and is independent of the magnitude of the after-effect. The tenacity of steel and brass decreases with increasing torsion. The number of twists leading to rupture decreases with increase of load when the load exceeds the elastic limit. By further loading, the number of twists decreases slowly, but not quite in straight-line relationship, until at the breaking strength the number of twists for fracture becomes zero.

F. C. A. H. L.

497. *Framed Structures under Eccentric Compression.* **H. Müller.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 10. pp. 166–181, 1910.)—The author discusses in detail two cases of built-up struts subject to eccentric loading, namely, one built up of, say, two channel sections connected by plain cross-pieces at right angles and the case where diagonal struts or lattice members are added. The mathematical analysis is somewhat complex: it suffices to say that the method employed involves the calculation of the deflection at each point of cross-connection. Each cross-connection is treated as a member subject to tension and two unequal couples. A series of formulæ are evolved which connect the bending moments, deflections, &c., at each panel with those in the next. Then by starting with known forces at one end of the strut it is possible to calculate both stresses and deflections throughout the whole frame. An example of the first type of strut mentioned above is worked out to show the application of the formula, and the author also shows how with eccentricity zero the formula can be reduced to the well-known form of Euler's equation: $P_k = \pi^2 EI/l^2$.

C. A. M. S.

498. *Tendency of Springs in Compression to Buckle Sideways.* **E. Hurlbrink.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 138–137, Jan. 22, and pp. 181–184, Jan. 28, 1910.)—The tendency of valve springs of cylindrical pattern to buckle sideways in compression has led to the adoption of various other types of springs of barrel, spherical, parabolic, and hyperbolic shape. Such springs, however, are unsatisfactory from several points of view. These considerations have led the author to make a thorough investigation into the mathematical theory of ordinary springs of cylindrical pattern and to determine the buckling pressure which is analogous to the case of long struts Euler. The investigation is quite general and somewhat complex. The author gives a summary as follows: The safety of cylindrical springs in compression against sideways buckling depends on the elastic constants of the material E and G; the dimensions of the cross-section and the total length (L) of the wire (incidentally the number of turns n). It also depends on the radius of the windings r, the uncompressed (e_1) and the compressed (e) length of the spring, and constants λ and η depending on the form of cross-section and method of loading respectively. Then S, the safety coefficient $= \lambda r^2/4\eta^2 e(e_1 - e) =$ (crit. pressure)/(working pressure), where $\lambda = 45$ for a circular section, 48 for a square section. $\eta = 1$ for springs with free pivots at ends; 0·5 for flat ends and fixed ends, and 0·67 for one end free and the other fixed. For safety, S should exceed 8 for springs with either free ends, fixed ends, or one end free and the other fixed. When flat unfixed ends are used S should exceed 6. Expressions are also found for the allowable compression and the allowable pressure on the spring for a given value of S and for various sections. C. A. M. S.

499. *Influence of Holes and Slots Cut on the Neutral Axis of a Beam on the Strength Modulus in Bending.* **C. Pfleiderer.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 848–852, Feb. 26, 1910. Extract.)—The author briefly discusses the usual assumptions, and then proceeds to the analytical discussion of the problem under review. He shows that the sections of the beam at top and bottom of the slot may be considered as two beams, subject to compression and tension respectively and at the same time under a bending moment analogous to the case of encastré beams. He deduces the formula—

$$\text{Stress } \sigma_b = hM_b/2\theta + \mu P l_1/4 \, . \, [1/af + (a - w_1/2)/\theta_1],$$

where σ_b is max. stress in neighbourhood of slit, $h =$ height of beam, M_b the bending moment at cross-section of the beam where slot commences, θ the moment of inertia of the beam as a whole where it is weakened by the slot, μ a number which in the case of cast iron $= \frac{1}{2}\sqrt{(h/a)}$ and for mild steel $= 1$. P is the shear stress at the same point as M_b is taken, l_1 is length of slit, w_1 its clear height, f the area of the cross-section on each side of the slit, θ_1 the moment of inertia on each side, and $2a$ is the distance apart of the centres of gravity of the two sections. The accuracy of the above formula has been demonstrated by a series of experiments carried out at the Technische Hochschule at Stuttgart. The experiments were carried out on grey cast-iron beams, a whole series of which are illustrated in the article. The series included beams with one and two slits varying in length from 0 to 240 mm. In each case the breaking stress was calculated according to the formula given and tabulated. These stresses exhibit a striking uniformity, all being in the neighbourhood of 2400 kg. per cm.^{2}, although for the same distance between supports the breaking load varied from 6410 kg. to 18,000 kg.

C. A. M. S.

500. *Contraction of Metals and Alloys.* **F. Wüst.** (Metallurgie, 6. pp. 769–792, Dec. 22, 1909.)—In the study of the contraction of metals, it is of importance to have a knowledge not only of the coefficient of contraction, but also of the volume-changes occurring during solidification and cooling. Apart from the measurements of Turner and Keep on cast irons, there are only a few isolated cases of measurement of contraction of other metals. For the measurement of contraction the author has designed an apparatus, calculated to eliminate the uncertainty of the levers used in magnifying the contraction in earlier designs. The metals are cast into bars of 500 mm. length in a mould, into the ends of which project stout iron wires ending in coils which become embedded in the bar during casting. The other ends of the wires are connected to pistons operating in water-tight cylinders. The two cylinders are filled with distilled water and connected jointly to a capillary measuring gauge. During the experiments changes in the volume of the bar are indicated by the movement of the liquid in the tube, which is read off by one observer while at the same time another observer takes a cooling curve by means of a thermo-couple placed in the centre of the bar. The results are plotted in the form of temperature-contraction curves, which are compared with the "inverse rate" cooling curves. Experiments were carried out on the metals Pb, Sn, Zn, Al, Cu, Bi, and Sb, and a large number of their technically important alloys. Chemical analysis and microscopic examination of each alloy was made. From the curves, the true coefficient of contraction of each metal can be derived, and the figures so obtained differ from the coefficient of expansion calculated from the usual formulæ, in some cases very considerably. The results lead to the general conclusions that: (1) Alloys whose components are mutually insoluble in the solid, contract less than either of the constituents, the eutectic alloy having the lowest coefficient of contraction; (2) alloys consisting of one or more solid solutions contract more than the constituent metals; and (3) there is no law connecting contraction and melting-point, either for metals or alloys. The paper contains forty diagrams, twenty-five tables, and forty-two photomicrographs. F. C. A. H. L.

501. *Friction in Gases at Low Pressure.* **J. L. Hogg.** (Phil. Mag. 19. pp. 876–890, March, 1910.)—In continuation of previous work [see Abstract No. 1819 (1906)], on the friction of gases, it is stated that after overcoming experimental difficulties in the use of a vibrating disc, the decrement due to friction in the suspending fibre has been determined; also, mercury vapour has been excluded from the apparatus to such an extent that mercury lines were absent from the spectrum of the gas enclosed. Further, the decrement has been obtained for hydrogen over a range of pressures from 1 atm. down to 0·000016 mm., and an equation has been found which relates pressure to decrement for all pressures below 0·1 mm., viz.—

$$\left(\frac{k}{l-\mu}-1\right)p=c,$$

where k and c are constants, l and μ the decrements due to gas and suspending fibre respectively, and p the pressure of the gas. The constants k and c can be determined from values of p between 0·1 and 0·01 mm. of mercury and the corresponding values of l. The pressures calculated agree with those made by the MacLeod gauge. The investigation is being extended to oxygen and nitrogen. G. E. A.

502. *Aerodynamical Autorotation.* **A. Etèvé.** (Comptes Rendus, 150. pp. 324–326, Feb. 7, 1910.)—When a pair of sectors joined at their apices are mounted on a pivoted spindle passing through their juncture and normal to their planes, they will, if placed in a current of air flowing parallel with the spindle, and given an initial movement of rotation, continue to rotate indefinitely in the direction of the initial movement, provided their edges are bevelled at the back. This effect is produced by eddy currents at the backs of the sectors. If the skin friction over the back surface is increased in the region of the trailing edge the rotation is as easy as with a smooth surface. The same influence applied to the region of the leading edge retards the movement. It is argued, from the observations made, that an increased efficiency is to be gained by making longitudinal striæ on the backs of high-speed air-propellers. C. A. B.

503. *Brownian Motion and Molecular Theory.* **J. Perrin.** (Annal. Chim. Phys. 18. pp. 5–114, Sept., 1909.)—Brownian motions may be shown to an audience by forming the filtered image of an electric arc or the sun within the preparation. The rays dissipated by the Brownian particles traverse an immersion objective and a highly enlarging eyepiece. But instead of direct vision the rays are reflected horizontally by means of a prism and thrown upon a piece of ground-glass, squared by preference. The audience is seated on the other side of the ground-glass. The magnification can thus be brought to 10,000 diams. without losing too much light. The preparation should contain grains several microns in diam. [see Abstract No. 2181 (1909)]. These may be obtained by very slowly adding water to a 5 per cent. alcoholic solution of gamboge or mastic. The diams. vary from $2\,\mu$ to $50\,\mu$. They may be sorted out by rates of falling. The verification of Einstein's equations (*loc. cit.*) gives a direct confirmation of the kinetic theory, and more particularly of the theorem of equipartition of energy among the degrees of freedom. If the kinetic theory is to be applied to visible particles, it must be borne in mind that their actual velocities vary enormously in small fractions of a second, and are not accessible to direct measurements. But one consequence of the kinetic theory is the logarithmic law of distribution according to height, which involves measurable quantities, such as the density and diam. of the grains. These may be obtained in the form of perfect spheres by adding water to an alcoholic solution of gamboge, or by leaving methyl alcohol in contact with mastic. Grains of the desired size are separated out by fractional centrifugation. The number of grains in successive layers $1\,\mu$ apart in water is counted by means of a microscope of high magnifying power and very small depth of view. The solution is viewed through a small hole pricked in tin-foil. This restricts the field of view to such an extent that the eye can seize the number of grains (up to 5 or 6) in the field at any given instant. Measurements made in this manner on gamboge particles $0{\cdot}212\,\mu$ in diam. at levels of $5\,\mu$, $35\,\mu$, $65\,\mu$, and $95\,\mu$ respectively, gave the comparative numbers 100, 47, 22·6, and 12, which agree well with the numbers 100, 48, 23, and 11·1 of the geometric progression law. After measuring the sizes of the particles by three concordant methods, the author gives the following extrapolation of Stokes' law: When a force, constant in direction and magnitude, acts upon a granule in Brownian motion, the displacement of the granule in the direction of the force increases with the time, and has a mean value $Ft/6\pi za$. Disregarding the irregularities of the motion, this gives a steady speed in the direction of the force. It also incidentally confirms Wilson and Thomson's counting experiments. E. E. F.

504. *Monsoons on the Chilian Littoral.* **R. C. Mossman.** (Roy. Soc. Edinburgh, Trans. 47. 6. pp. 137–141, 1909.)—Discussion of the wind observations made at stations on the coast of Chile during the years 1901–5 reveal a well-marked monsoonal variation of direction north of lat. 40° S. At Ponta Galera (40° S.) in Jan. 64 per cent. of the observations are from between SE. and SW., and only 26 per cent. from between NW. and NE. In June 66 per cent. are from the northerly direction, and only 16 per cent. from the southerly. At stations further to the north the difference between the two seasons is even more conspicuous. South of 40° S. no monsoonal wind change is shown. At Ancud (41° 50′ S.) the westerly winds are the most frequent throughout the year. The rainfall is also strictly monsoonal in character. At Ponta Galera (annual total, 105 in.) 18·5 in. fall in June with northerly winds, and only 2·8 in. in Jan. with the southerly winds. Similar conditions prevail at the other stations. North of lat. 38° S. the monsoonal character of the wind is masked, if not entirely absent, but the rainfall, which is very light, is practically confined to the southern winter. R. G. K. L.

505. *Application to the Relativity Theory of the Geometry of Lobatschefskij.* **V. Varičak.** (Phys. Zeitschr. 11. pp. 93–96, Feb. 1, 1910.)—For the composition of the velocities in the relativity theory we may use the formulæ of spherical trigonometry with imaginary sides, as recently shown by Sommerfeld [see Abstract No. 12 (1910)]. Now the non-Euclidean geometry of Lobatschefskij and Bolyai is the imaginary counterpart of the spherical, hence it is easy to see that an interesting field of application is here open to the hyperbolic geometry. The paper then develops the subject on these lines, a new variable u being taken, such that $\tanh u = v/c$, where v is the speed of the body under consideration and c that of light. Thus the factor $(1 - v^2/c^2)^{-1/2}$, so often recurring in the Lorentz theory, here becomes $\cosh u$. E. H. B.

506. *Theory of the Light Intensity of the Sky.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 899–921, June, 1909.)—Expressions are found for S, the intensity of illumination of a horizontal surface by direct sunlight, and H its illumination by scattered light on the assumption that the atmosphere may be regarded as a hemisphere of radius R, containing q light-scattering particles in each unit volume—

$$S = \cos z\, p^s,\quad H = -3/32 \,.\, \log p/\log e \,.\, (5 + \cos^2 z),$$

where z is the zenith distance of the sun, p the transmission coefficient, and s the length of path of the direct ray through the atmosphere, expressed in atmosphere-thicknesses. The intensity of light outside the atmosphere is taken as unity. A table is given of values of S, H, S + H, S/H, for $p = 0{\cdot}6$, corresponding with values of z ranging from 0° to 80°. For $z = 54°$, S = H. The relative values of S and H agree fairly well with direct photochemical measurements made by Wiesner in Vienna, who found S = H when $z = 57°$. Roscoe, at Lisbon, found a more rapid increase of H with z than is given by the formula. At higher altitudes p increases. If $p = 0{\cdot}75$, S = H for $z = 70°$. The results given by the formula then agree with observations made by Wiesner in Yellowstone Park, U.S.A. He there found values for the ratio S/H of 4 or above; the formula gives $S/H = 4{\cdot}63$, for $z = 0$ and $p = 0{\cdot}75$. The second part of the paper deals in similar manner with the illumination of a vertical surface, and the third with the distribution of luminosity over the sky. R. G. K. L.

507. *The Variograph: an Instrument for recording Rapid Oscillations of Atmospheric Pressure.* **W. Schmidt.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 885–897, June, 1909. K. k. Zentralanstalt f. Meteorol. u. Geodynamik, Wien.)—The instrument, to which the name variograph has been given, records not the atmospheric pressure but the first differential of this quantity. A large vessel, protected from temperature variations, communicates with the outer air through a tube which admits of free circulation. Variations of atmospheric pressure cause a flow of air through the communicating tube. The velocity of this air-flow gives us a measure of dp/dt. In the apparatus as used, the vessel (capacity 35 to 40 litres) is filled with coal gas. It communicates with a gas-burner through a fairly wide tube, in which a small capillary is interposed, to eliminate the effects of what we may call almost instan-

taneous charges of pressure of local origin. There is an ingenious device for supplying gas to the system at the same rate as it escapes from the burner. A sudden increase of pressure causes a diversion of the gas supply to the reservoir and consequent diminution of the flame, and *vice versâ*. A steady rise of pressure gives a steady flame. Variations in the size of the flame, or rather in the amount of gas escaping from the burner, are measured by placing above the flame a bi-metallic thermometer, the indications of which are found to be directly proportional to the flow of gas through the burner. The thermometer is made self-recording. Specimen records and particulars of the calibration of the instrument are given with the paper. R. G. K. L.

508. *Periodic Variations of Pressure, Temperature, and Wind in the Atmosphere.* **E. Gold.** (Phil. Mag. 19. pp. 26–49, Jan., 1910.)—The paper finds mathematical expressions for the variations of wind velocity and temperature which must be associated with a given periodic variation of pressure. The usual method of procedure has been to find the pressure variations and wind which must result from a given periodic temperature-variation. For simplicity the problem was confined to the case of a thin shell of atmosphere in which vertical variations could be neglected. The results gave a considerable discrepancy between the observed and the calculated phases of the pressure and temperature waves. For frictionless motion the phase-difference should be zero for the diurnal variation, and if we assume a large friction constant, the calculated phase-difference varies from 88° at the equator to zero at the poles. Observation gives a difference of 180° for the mean of 18 stations. Similar discrepancies appear in the case of the semi-diurnal variations. If we take account of the observed change in the pressure variation with altitude, the temperature variation, which must be associated with the pressure variation according to the hydrodynamical equations, is found to be in fair agreement with the observed temperature variation. R. G. K. L.

509. *Mean Height of the Snow Line, and Proportion of Snow to Rain in Switzerland.* **J. Maurer.** (Meteorolog. Zeitschr. 26. pp. 539–546, Dec., 1909.)—(1) A summary of the 20 years' observations of the height of the snow line made at the Säntis Observatory. The average max. height occurs during the pentad Aug. 14–18 at an altitude of 2870 m. There is a peculiar secondary minimum, 1,415 m., during the pentad Oct. 18–22, after which the value rises again to 1,679 m. during the pentad Nov. 2–6. (2) The percentage of total precipitation falling as snow is found to increase in approximately linear proportion with increase of altitude. Taking the Swiss Alpine region as a whole, 100 per cent. is reached at an altitude of about 3400 m.

R. G. K. L.

510. *Cold Waves in Europe during the Winter,* 1908–1909. **A. Fessler.** (Meteorolog. Zeitschr. 27. pp. 1–12, Jan., 1910.)—So-called cold waves are assigned to two types: (1) the transport of cold air from distant regions; (2) cooling of the earth's surface and of the air in contact with it by radiation. Under suitable conditions, both causes may act together. The cold wave which spread over Europe from Oct. 16 to 23, 1908, is a typical example of the first type. Taking the isotherm of 0° C. at 7 a.m., as marking the advance of the wave, we can trace its progress from the neighbourhood of Moscow on the 16th to the West of France on the 23rd. In the North, the shores of the Baltic and North Sea mark the limit of the region within which temperatures below freezing-point occurred. In the South the Carpathians

and the Alps form an equally effective barrier to the advance of cold air. Additional evidence that the fall of temperature is in this case due to the transport of cold air is afforded by the wind observations. From Oct. 15 to 18, the 0° C. isotherm advanced towards the South-west through about 500 km., *i.e.*, at the rate of about 20 km. per hour. This velocity is approximately that of a wind of force 3 or 4 on the Beaufort scale, and we actually find the strongest winds recorded for these days given as NE. 3–4. Several other cases are similarly examined. Some (*e.g.*, Jan. 21, 1909) are classed as pure examples of Type 2, but the majority show a combination of both types.

R. G. K. L.

511. *Surface Deformation and the Tides.* **J. Milne.** (Nature, 82. p. 427, Feb. 10, 1910.)—A British Association type of seismograph was installed at Bidston Observatory, near Birkenhead, and about $1\frac{1}{4}$ miles from the sea. A multiplying lever attached to the boom gave 1 mm. displacement on the bromide paper for a tilt of 0·08″ of the pendulum stand. It was found that at high tide the bed of the Irish Sea is depressed and the steepness of the bounding shores is increased. The deflection of the pendulum by tidal load and attraction, although greater than might be expected, is, however, very small. At Bidston the tilting is about 0·2″, or 1 in. in 16 miles. A. D. R.

512. *Barograph as Seismoscope.* **de Montessus de Ballore.** (Comptes Rendus, 150. pp. 486–487, Feb. 21, 1910.)—Sudden alterations of atmospheric pressure recorded by a barograph at Santiago during the four years 1906–9 are compared with the corresponding records of Wiechert horizontal and vertical pendulums. 57 per cent. of the former correspond with macroseisms, and hence, at the best, the barograph is only a very unreliable seismoscope. No connection is found between the barometric change and the amplitude or period of the seismic waves or the distance of the seismic centre.

A. D. R.

513. *Seismic Radiations and the Earth's Interior.* **K. Zoeppritz** and **L. Geiger.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 400–428, 1909.)—The paper is in continuation of the work of Wiechert and Zoeppritz on the propagation of seismic disturbances [Abstract No. 1048 (1908)]. Employing Wiechert's method—based on the curve for the sine of the incidence angle as a function of the source distance—the paths of the first and second phase waves are calculated. From these are deduced the velocities of the preliminary tremors for all depths of path, and hence the value of Poisson's elastic constant for the earth's material at various depths. The results are compiled in a series of tables. Poisson's constant varies from 0·258 near the surface to about 0·271 ± 0·003 at depths of 100 to 1200 km.

A. D. R.

514. *Seismic Observations.* **A. Lo Surdo.** (Accad. Lincei, Atti, 19. pp. 19–23, Jan. 2, 1910.)—The intensity of an earthquake has hitherto been measured on an arbitrary scale, the most frequently used being those of Mercalli, Rossi-Forel, or Omori. The apparatus recently described by the author [Abstract No. 229 (1910)] for the determination of seismic acceleration enables the intensity to be measured in absolute c.g.s. units with the greatest ease. The length of liquid column (L) recommended is 49 cm., and ratio (n) of the cross-sections 100, the period then being about $\frac{1}{10}$ sec., and the sensibility 0·025 cm. W. H. St.

515. *Seismic Observations.* **G. Lippmann.** (Comptes Rendus, 150. pp. 363–366, Feb. 14, 1910.)—The author employs as seismographic pendulum a horizontal tube terminating at each end in a wide cup, and filled with water. Unlike Lo Surdo's instrument [Abstracts No. 229 (1910) and preceding Abstract] this is sensitive to very feeble displacements, and it is made self-recording by placing a very thin mica plate on the surface of the water in one of the cups, which, without touching the sides, follows the movements of the water, and by connection with a mirror reproduces them on a photographic plate. The period can be increased at will up to 20 or 30 seconds, but one of 10–12 seconds is the most convenient, as with a high period the apparatus becomes extremely sensitive to external conditions, *e.g.*, hourly change in the sun's position or approach of the observer. The instrument does not indicate slight vertical displacements. W. H. St.

516. *Earthquake of January* 22, 1910. **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 3. pp. 211–216, Feb. 15, 1910.)—Results obtained by the Pulkowa horizontal pendulum are discussed. Employment of the author's method of reduction [see Abstract No. 20 (1910)] gives the epicentrum at lat. 68° N., long. 17° W. This is shown to be in good agreement with determinations based on readings at several stations. The max. N.-S. amplitudes are tabulated and compared with those in the Messina earthquake. A. D. R.

517. *Results of Investigations of Solar Spectrograms of* 1896. **V. K. Lebedinskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 9. pp. 395–398 (Physical Part), 1909.)—The author describes spectrograms taken with the help of a prismatic camera during the total solar eclipse of 1896. The spectrogram taken at about the moment of the third contact shows the spectra of the sickle-shaped chromosphere and of the rotating layer and the Fraunhofer spectrum of the sickle-shaped photosphere emerging from the moon's disc. In the great majority of cases the spectral lines of the rotating layer exhibit possible identity with the Fraunhofer lines of Rowland's tables, but with twenty of these lines this is not the case. The chromospheric lines of the spectrogram taken at about the moment of second contact are forked—an observation which the author regards as being connected with the existence of a large protuberance at that part of the sun's edge to which the spectrogram refers. This protuberance takes the form of a bright point on the sun's surface, with two parabolæ starting from it and returning to the surface of the sun at the side opposite to the bright spot. T. H. P.

518. *Radial Movement in Sun-spots.* **J. Evershed.** (Roy. Astronom. Soc., M.N. 70. pp. 217–225, Jan., 1910.)—In a former paper [Abstract No. 994 (1909)] it has been shown that certain line-displacements found in the spectra of sun-spot penumbræ might be explained by assuming an outward radial movement, parallel to the sun's surface, of the gases in the reversing layer over spots. It was also necessary to suppose the movement to accelerate outwards from the umbræ, attaining a max. value of 2 km. per sec. at the outer edges of the penumbræ. During the past year the spectrum of every available spot has been photographed at some time during its transit across the sun, and, without exception, all have shown the same systematic line-displacements. The lines have invariably been found to incline towards the red on the side of the spot nearest the sun's limb, and towards the violet on the side nearest the centre of the disc, whatever position the spot may have occupied, provided it be not too near the centre. In a few cases the motion has been detected when the spot was very near to the central meridian. If these displacements are really due to motion the only promising explanation appears to be that spots are centres of a force directed radially outwards in a horizontal plane. In order to find the source of these vapours, special attempts have been made to detect any vertical motion in the umbræ of spots, but hitherto only negative results have been obtained; the only evidence suggests, indeed, a slight downward movement of the umbral vapours, of about 0·4 km. per sec. Two notable exceptions to the general law of displacement towards the red are found in the H$_3$ and K$_3$ absorption lines of calcium, which are displaced towards the violet on the limb side of a spot, indicating an indraught of calcium vapour. Moreover, the distortions of the H$_3$ and K$_3$ lines are continued far beyond the outer edge of the penumbra, while the ordinary Fraunhofer lines are only altered to the penumbral boundary. Continued examination of these spectra has resulted in the detection of a residual velocity in the nodal position, indicating a spiral movement of the spot vapours in place of a linear one from the centre. This twist amounted in many cases to about 8°, and the residual motion to about 0·8 km. per sec. on each side of a spot. Several analogies are found with the behaviour of the widened spot lines. Thus Hale found the magnetic field to decrease rapidly with increasing distance from the photosphere, the doublets and triplets of iron giving much stronger fields than the lines of Na and Mg, which are known to exist at a higher level. The greatest radial motion of 2–3 km. per sec. is found in the region of iron absorption, while the D lines of sodium are scarcely affected. C. P. B.

519. *Spectrum and Temperature of the Solar Photosphere.* **A. Amerio.** (Accad. Lincei, Atti, 19. pp. 15–19, Jan. 2, 1910.)—The author's previous deduction that the solar photosphere radiates as a black or almost black surface [Abstract No. 22 (1910)], places calculations of its temperature based on the heat emitted, on a firmer basis. The distribution of energy on the solar disc has been measured for various wave-lengths with a spectrobolometer, observations being made at sea-level at Messina, at Col d'Olen (2980 m.), and at the Monte Rosa Observatory (4560 m.), readings at different altitudes eliminating the influence of absorption by the terrestrial atmosphere. From the results obtained the spectra for a number of points on the solar disc have been constructed, and, taking account of their position, the extent of absorption by the solar atmosphere is calculated and the spectrum of the photosphere deduced. It is concluded that the solar atmosphere exercises a diffusive absorption which increases gradually with diminution of wave-length. W. H. Sr.

520. *Ultra-violet Light Photographs of the Moon.* **R. W. Wood.** (Roy. Astronom. Soc., M.N. 70. pp. 226–228, Jan., 1910.)—The possibility of much interesting research is suggested by a study of the petrography of the moon's surface, using photographs obtained with light confined to comparatively narrow ranges of the spectrum. An area near the lunar crater Aristarchus is shown dark when photographed with ultra-violet light, and light when in yellow light. The wave-length used for the ultra-violet test was about λ3100–3250, and as this will not pass through glass, it was necessary to use a quartz lens, coated with a film of metallic silver to absorb the visible and some of the invisible rays. The focal length of the lens was 6 ft. and the aperture 3 in. Later a concave speculum of 6 in. aperture and 11 ft. focal length has been used. Laboratory studies of various volcanic ejecta and igneous rocks

show that specimens appearing exactly alike in yellow light may be very different in ultra-violet light. This same differentiation has been found in the case of sulphur and zinc oxide. The fact that the bright streaks on the moon come out equally bright on the two pictures proves that the white substance is neither of these. For further research a large image is required, say a speculum mirror of 30 or 40 ft. focus. C. P. B.

521. *Intrinsic Brightness of the Sun.* **C. Nordmann.** (Comptes Rendus, 150. pp. 448–451, Feb. 21, 1910.)—The effective temperature determined with the author's pyrometer was found to be about 5320° abs. Now, the brightness of an incandescent body emitting white light varies sensibly as a function of the temperature, and this law has been verified by comparison with numerous terrestrial light sources. Taking into consideration the absorption of the solar atmosphere, the effective temperature of the photosphere is probably about 6450° abs. The corresponding brightness of the mean effective layer is then about 319,000 decimal candles per cm.^{2}. The solar surface is thus considered to behave very like a black body, and to have an emissive power of nearly unity. C. P. B.

522. *Markings on Jupiter.* **S. Bolton.** (Roy. Astronom. Soc., M.N. 70. pp. 233–237, Jan., 1910.)—Observations of Jupiter made during the period 1907 Aug. 27–1908 July 4 showed the existence of a considerable amount of fine detail in the structure of the chief belts. On the N.N.N. temperate belt a number of faint dark spots and irregularities were visible. To the south the belt bordered several white oval spots situated in the N.N. temperate zone. *N.N. temperate belt.*—This was a trifle darker than corresponding Southern band, but decidedly fainter than S. temperate band. On the whole it presented normal activity, and was continuous throughout. Its average width was 2·6°, and it was generally of a steely-grey colour. A number of faint dark spots were visible, associated with wispy shadings extending along the N.N. temperate zone. *N. temperate belt.*—Several noteworthy outbreaks of dark matter were seen, especially on the red-spot side of the planet. *N. equatorial belt.*—The great activity shown during the previous apparition had practically ceased, the irregularities along both edges becoming less obvious. It was almost as dark as in 1906–7, and by far the darkest belt on the planet. During the first few months it still retained some of the distinctive brick-red colour, but later this was replaced by a reddish-brown hue. *S. equatorial belt.*—Mean width 9·9°. In colour it was distinctly cooler than the N. equatorial belt, being dull purple-brown and greyish purple, and slate-brown preceding the hollow. The north component contained a number of spots of varying intensity, most of these being connected with crests on the North equatorial belt by transverse wisps crossing at varying angles to the planetary equator. *Red spot and hollow.*—The spot became difficult to perceive as the junction between it and the hollow proceeded, but the hollow preserved its distinctive outline throughout. *South Tropic Area.*—This remarkable object may be likened to a darkened section of the S. tropical zone, confined solidly within two prominent and well-defined wisps. Throughout the epoch of conjunction the outline of the red spot was more or less obscured by patches of both light and dark matter, which to all appearances drifted across it. The southern half of the spot was perceptibly shaded, the shading becoming deeper in tone towards the S. temperate belt. C. P. B.

523. *New Canals on Mars.* **P. Lowell.** (Nature, 82. pp. 489–491, Feb. 24, 1910; also Comptes Rendus, 150. p. 448, Feb. 21, 1910.)—On Sept. 30, 1909, when the region of the Syrtis Major came into view, two striking canals were at once evident to the east of the Syrtis, in places where no canals had previously been seen. One ran from the bottom of the Syrtis (lat. 20° N., long. 285°), the other from a point part of the way up its eastern side (lat. 17° N., long. 284°). Curving slightly to the left as they proceeded south, they converged to an oasis, itself new, on the Cocytus (lat. 5° N., long. 265°), about two-thirds of the distance to where that canal meets the Amenthes. With the two main canals were associated several small ones. These details were noted by E. C. Slipher and the author, and were subsequently photographed by Lampland. Thirty images were taken on each plate, and practically all show the new canals. Similar photographs taken in 1907 show no such features in this region. Reference to previous drawings made of the same region during Aug., July, June, and May, failed to show any trace of their having been observed; the same remark applies to the recorded observations of previous years since 1894. The epochs at which similar seasonal presentations of the region have been observed were specially noted, but no record of these two canals was found. Additional evidence is given by a peculiarity of canal formation, in that while the great majority of the canals are quickened into conspicuousness alternately every six Martian months, first from the south and then from the north polar cap, there are some which respond only to one or the other cap. No canals in the position of these two new ones could be traced in the records. It would thus appear that they are actually new objects to Mars. The possibility of their being of artificial formation is then discussed. C. P. B.

524. *Comet* 1910*a*. **E. Esclangon.** (Comptes Rendus, 150. pp. 369–372, Feb. 14, 1910.)—Observations made on the great comet at Bordeaux on Jan. 22, 23, 30, 31, Feb. 9, 1910. Between Jan. 22 and 30 the comet was subject to numerous changes of form and brightness. At first the nucleus was very brilliant, having a diam. of about 15″, and the general form of the tail resembled that of Comet Daniel 1907*d* [see Abstract No. 577 (1908)]. On Jan. 30 the general brightness was much decreased, the nucleus only about 3 to 4″ of arc in diam., and the double division of the comet, formerly so prominent, had given way to a large nebulosity surrounding the nucleus eccentrically. The tail at this stage attained a length of 25°. It is important to note, however, that the angle made by the direction of the tail with the line joining comet—earth varied considerably between the above dates. **J. C. Solá.** (Ibid. pp. 372–374, Feb. 14, 1910.)—Photographs obtained with the Mailhat Equatorial of Fabra Observatory, exposure about 6 sec., show all the observed details of the bifurcated tail, the form and dimensions of the head. Exposures up to 22 min. have been given for recording the delicate details of the aigrettes and tail. The chief features were the curvature of the tail and the secondary tail developed during the decline of the comet in visual brightness. C. P. B.

525. *Diagrammatic Representation of Proper Motions.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 70. pp. 204–216, Jan., 1910.)—A simple method has been devised for representing the sphere on a flat surface so that problems expressed usually in spherical co-ordinates may be graphically represented. The sphere is projected from its centre on to the circumscribing cube, and the cube then unfolded, showing six squares. The great circles of the sphere are then represented by a series of straight lines on the faces of the cube, forming broken lines. The method is applied to discuss the proper motions of stars in certain groups which have been treated analytically by other observers. C. P. B.

REFERENCES.

526. *Mercury Manometer for Small Pressures.* **K. Scheel** and **W. Heuse.** (Zeitschr. Instrumentenk. 30. pp. 45–47, Feb., 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—Description of a manometer for pressures up to 100 mm., the instrument being surrounded by a jacket by means of which it can be heated. [See Abstract No. 368 (1909).] G. E. A.

527. *Analysis of a Periodic Function.* **S. Oppenheim.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 823–848, June, 1909.)—A mathematical discussion is given of a method for calculating the period or periods of a function, given the values of that function at a number of equidistant epochs. The method is applied to determine the exact lengths of the 11-year and other periods in the secular change of magnetic declination. From the data for 1750 to 1900 four periods are found, viz., 4·9208, 11·1868, 31·279, and 59·034 years. A. D. R.

528. *An Illimitable Atom.* **F. W. Dodd.** (Engineering, 89. p. 311, March 11, 1910.)—Since attractions and repulsions of atoms occur at indefinite distances and are ascribed to lines or tubes of forces connecting them, it is pointed out that some of these lines or tubes must extend indefinitely. Hence, under this conception, the atom becomes infinitely large instead of almost infinitely small. E. H. B.

529. *Oscillations of Superposed Fluids.* **H. J. Priestley.** (Cambridge Phil. Soc., Proc. 15. No. 4. pp. 297–309, Jan. 31, 1910.)—Mathematical.

530. *Waves in a Dispersive Medium resulting from a Limited Initial Disturbance.* **G. Green.** (Roy. Soc. Edinburgh, Proc. 30. pp. 242–253, 1909–1910.)—In continuation of the treatment dealt with in Abstract No. 1694 (1909).

531. *Propagation of Disturbance in a Fluid under Gravity.* **F. B. Pidduck.** (Roy. Soc., Proc. Ser. A. 83. pp. 347–356, March 2, 1910.)—Further remarks on the phenomenon of the instantaneous propagation of a limited disturbance over the surface of heavy incompressible fluid, to which attention was called by Rayleigh [see Abstract No. 42 (1910)].

532. *Distribution of Temperature near the Earth's Surface.* **P. Vujević.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 971–1018, July, 1909.)—Hourly observations for the lustrum 1902–1906 of bright bulb thermometers freely exposed to all radiation are discussed in this paper. Four thermometers were used; they were placed respectively on the ground and at heights of 0·4, 1, and 2 m. above the ground. The observations were made at the Meteorological Observatory at Belgrade. R. G. K. L.

533. *Survey of Star Cluster G.C. 341.* **E. Fagerholm.** (Ark. för Mat. Astron. och. Fysik, Stockholm, 5. 14. pp. 1–128, 1909.)—From a series of measures of six plates of the star cluster G.C. 341 taken with the large refractor of the Upsala Observatory from Sept. 17 to Nov. 7, 1907, a table is compiled giving the rectangular co-ordinates of 283 of its constituent stars. The work will form a useful comparison for future analysis of variations among cluster stars. C. P. B.

534. *Temperature Classification of Stars.* **Wilsing** and **Scheiner.** (Astronom. Nachr. No. 4375. Nature, 82. p. 228, Dec. 23, 1909. Abstract.)—From a series of spectrophotometric determinations the authors give a list of effective stellar temperatures including 109 bright stars. The extreme values found are χ Serpentis = 2800° abs.; λ Orionis = 12,800° abs. C. P. B.

LIGHT.

535. *New Reflectometer.* **C. Féry.** (Comptes Rendus, 150. pp. 691–693, March 14, 1910.)—The author deals with a method of determining the index of refraction of liquids by total reflection from a curved surface. In a block of glass a hemispherical cavity is bored, and another piece of glass just fits into this cavity. The liquid under investigation is placed between the two hemispherical surfaces, which are then observed by means of a telescope. From the diam. of the dark ring seen in the telescope the index of refraction is calculated by a simple formula. E. M.

536. *Prism with Curved Faces for Spectroscopic Purposes.* **C. Féry.** (Comptes Rendus, 150. pp. 216–217, Jan. 24, 1910.)—A prism with spherically curved faces which does away with the use of any lens. The curvature of the two faces is different, and the one with the larger radius of curvature is fully silvered, so that all light falling upon it is reflected. The arrangement of the prism is similar to that of the concave grating, for the focus circle has a diam. equal to the radius of curvature of the unsilvered glass surface. The centre of curvature of the back, or silvered, surface also lies upon this focus circle. The position of the slit best suited for the instrument can be arrived at by a simple calculation. The instrument is astigmatic, like the concave grating. E. C. C. B.

537. *Measuring Transparency.* **L. H. Friedburg.** (Journ. Phys. Chem. 14. pp. 84–87, Jan., 1910.)—A polarised-light apparatus for determining the opacity of developed photographic plates. An opaque plate, not rotating the plane of polarisation, when interposed between two parallel mounted tourmaline plates cut parallel to their optical axes, will reduce the angle of 90° between extreme brightness and max. darkness by an amount proportional to the density of the silver deposit. A. D.

538. *Lecture Experiment on the Pressure of Light.* **A. Amerio.** (N. Cimento, 18. pp. 424–429, Nov.–Dec., 1909.)—One of the objections to Poynting's method of illustrating the pressure of light is that the use of blackened glass is accompanied by intense radiometric action, so that a slight dissymmetry of the system or of the beam is sufficient to produce rotation. Further, a surface blackened with Indian ink is granular with respect to the wave-length of the light used, so that there will be a greater heating of the granules of the part turned towards the rays, and hence a predominant radiometric action towards the ray. An improvement on this method consists in using a cylinder, about 8 cm. in diam. and 1 cm. high, made from a sheet of thin Al blackened with Indian ink and covered with a thin layer of transparent varnish; the silk fibre by which the cylinder is suspended lies in the prolongation of the axis. The support of the absorbent material, being a good conductor of heat, causes a diminution of the radiometric effect owing to the small difference of temperature between its two faces; the distribution of the energy of the incident beam may be asymmetric without causing inconvenience, since all the radiometric actions converge towards the centre, and lastly the thin layer of varnish removes the objection that the radiometric action may not be perpendicular to the surface. Radiometric action may be eliminated entirely by attaching two very thin cover-glasses to the ends of a slender horizontal glass rod and in the vertical plane passing through the rod. This system, which may be either furnished with the usual mirror or arranged for observation by Poggendorf's method, is suspended by a thin quartz or silk fibre and is introduced into a large thin-walled glass flask with wide neck; the flask, which is placed on a support rotatable about a vertical axis, is closed with a metallic cover provided with a metallic tube for connection with an air-pump. The pressure in the flask is reduced to a few mm. of mercury, and the light from the sun or a powerful arc lamp, after passing through a nicol, is concentrated on one of the cover-glasses by means of a suitable system of lenses, the angle of incidence being equal to the angle of total polarisation. If the vibrations take place in the plane of incidence, the glass allows the whole of the incident energy to pass through it, so that no pressure can be exerted. If, now, the nicol be rotated through 90°, 15 per cent. of the incident energy is reflected at the first surface, 15 per cent. of the remainder at the second surface, and 26 per cent. in the region between the two faces; this energy exerts a pressure which causes the system to rotate. T. H. P.

539. *Absorption and Refraction of Light in Colloidal Metal—especially Gold—Solutions.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 867–888, June, 1909.)—The author takes Hasenöhrl's calculations of the changes undergone by a plane-polarised electromagnetic wave traversing a medium composed of uniformly distributed spheres with dielectric constant, permeability and conductivity different from those of the surrounding medium [Abstract No. 1348 (1908)] as a starting-point for determining the dependence of the absorption and refraction coefficients of a colloidal metal solution on the number and magnitude of the suspended particles. These particles are regarded as spheres of equal radii, and it is assumed that they are distributed uniformly throughout the water and that their distance apart is large compared with their diam., so that the action of one sphere on the others may be neglected, that is, only very dilute colloidal metal solutions are considered. The results of the author's calculations are discussed in relation to those of Mie [Abstract No. 594 (1908)] and of Gans and Happel [Abstract No. 1242 (1909)], with which they are in agreement. The absorption and dispersion curves of a red colloidal gold solution containing 0·011 gm. of gold per 100 c.cm. have been calculated and are found to be of the same form as, but not coincident with, the observed curves. T. H. P.

540. *Change of Positive Reflection into Negative by Pressure.* **O. Lummer** and **K. Sorge.** (Ann. d. Physik, 31. 2. pp. 825–842, Jan. 28, 1910.)—Rayleigh [see Abstract No. 1778 (1908)] has recently shown that "positive" reflection at a strongly refracting glass surface can be changed into "negative" by treating the surface with polisher's rouge, &c. (The reflection is designated as "positive" or "negative" according to the sign of $\delta_p - \delta_s$, δ_p and δ_s denoting the changes of phase, due to reflection, of the components of the elliptically polarised light parallel and perpendicular respectively to the plane of incidence.) Rayleigh's experiments, and other circumstances, have led the authors to doubt the sufficiency of Drude's surface-layer theory to explain the phenomena of reflection, and they have therefore undertaken experiments in order to test the question. In any case, they show, Drude's formulæ require certain alterations to make them fit the facts. The results of their

researches lead the authors to believe they have proved, for the first time, that elliptical reflection at a reflecting surface can at least be considerably *altered* by mechanical alteration of the medium, though the surface remains untouched. But whether the ellipticity can be *originated* by mechanical alteration of the reflecting medium is another question. Further experiments are required in order to decide whether such ellipticity as is already present had its rise in the processes of preparing the material or whether external surface films are responsible for it. A. E.

541. *Optical Properties of Colloidal Gold.* **L. Rolla.** (Accad. Lincei, Atti, 19. pp. 141–146, Feb. 6, 1910.)—Colloidal solutions of gold, prepared by the action of glycerin and potassium carbonate upon gold chloride solution, have been examined with a Siedentopf and Zsigmondy ultramicroscope, and the following results obtained, the K_2CO_3 solution and water being added, together with 2 c.cm. of 20 per cent. glycerin solution, to 25 c.cm. of 6 per cent. gold chloride solution, and the whole warmed.

	c.cm $N/18K_2CO_3$.	c.cm. H_2O.	No. of Granules per $mm.^3$.	Colour.
1	0·0	100·0	4×10^7	Blue (by transmitted light)
2	1·0	99·0	2×10^7	Ditto
3	2·0	98·0	5×10^5	Blue-violet (by transmitted light)
4	2·2	97·8	3×10^5	Violet
5	2·5	97·5	—	Violet
6	3·0	97·0	$9·3 \times 10^4$	Reddish violet
7	10·0	90·0	$7·8 \times 10^4$	Red
8	20·0	80·0	2×10^4	Red
9	50·0	50·0	0	Red

Spectrophotometric measurements of the absorption of light passing through colloidal solution No. 9, show that for this hydrosol Beer's law is valid. Assuming that either all the gold chloride passes into the colloidal state, or the ratio between the concentration of suspended gold, and that of the molecular gold may be regarded as constant in the various hydrosols, then the variation in absorption for light of different wave-lengths should depend on the ratio between amicrons and submicrons. The following table gives the coefficient of absorption for light of different wave-lengths by the various colloidal solutions :—

λ.	No. 2.	No. 4.	No. 6.	No. 9.
650………………	0·0291	0·0240	0·0197	0·0097
595………………	0·0343	0·0295	0·0299	0·0239
550………………	0·0386	0·0378	0·0374	0·0380
515………………	0·0297	0·0318	0·0308	0·0320
488………………	0·0260	0·0272	0·0269	0·0271
468………………	0·0202	0·0202	0·0240	0·0237

W. H. St.

542. *Measurement of Refractive Index of Liquids.* **L. Décombe.** (Comptes Rendus, 150. pp. 889–891, Feb. 14, 1910.)—The method described is similar to that of Brewster, but it is claimed to be much more accurate.

The liquid under investigation is placed between a plate of plane-parallel glass and the curved surface of a plano-convex lens. A microscope is focussed on the upper surface of the plate and on the image of a source of light placed beyond the plate, and from these observations the refractive index is calculated by a simple formula. The method only requires a drop of the liquid under investigation, and is also applicable to translucent liquids. When the instrument has been standardised only one observation is required to obtain the refractive index of a given liquid. E. M.

543. *Optical Constants of Certain Elements.* **H. v. Wartenberg.** (Deutsch. Phys. Gesell., Verh. 12. 3. pp. 105–120, Feb. 15, 1910. Communication from the Physikal.-chem. Inst. d. Univ., Berlin.)—A determination of the refractive index, absorption coefficient, and reflecting power, for yellow light, of certain metals of which the black body melting-points had been optically measured. The results are given in the following table :—

Substance.	Index.	Absorption Coefficient.	Reflecting Power. per Cent.
Mn	2·49	3·89	63 5
Cr	2·97	4·85	69·7
V	3·03	3·51	57·5
Ta	2·05	2·81	48·3
Nb	1·80	2·11	41·3
Wo	2·76	2·71	48·6
Pd	1·62	3·41	65·0
Rh	1·54	4·67	78·3
Ir	2·13	4·87	74·6
Pt	2·03	4·4	71·3
90Pt, 10Rh	1·79	4·20	71·7
Si	3·87	0·47	35·7
C	2·98	1·74	36·7

G. E. A.

544. *Gaseous Dispersion.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. pp. 907–913, Dec., 1909. Extract.)—In a previous paper [see Abstract No. 1495 (1907)] the author discussed the application to gases of the mono-electronic non-absorptive equation due to H. A. Lorentz—

$$(\nu^2 + 2)/(\nu^2 - 1) = \Delta(1/\lambda_0^2 - 1/\lambda^2),$$

where ν is the refractive index, λ the wave-length, and λ_0 and Δ denote constants. It was found that the formula was in thorough accord with observation over the whole range of ordinary (or normal) dispersion. Moreover, from the relation $\Delta = 3\pi c^2 m/e^2 N$ (where e is the charge on the electron, m its mass, and N the number of *dispersion electrons* per unit volume of the medium) it was concluded that, if a is the number of dispersion electrons in the molecule, the product $a\Delta$ ought to be *a universal constant.* Judging from the value of e/m now generally accepted, that of this constant should be about $12{\cdot}5 \times 10^{-7}$ cm.^{3}. But it was found that the average value for this supposed constant gave the higher number 16·3 if, for a, were written v, the aggregate number of valency units by which the atoms in the molecule are supposed to be linked. A number of cases and the corresponding values are now discussed, and though in particular cases the suggested rule appears contradicted by experiment, it is concluded that the balance of probability is decisively in favour of the law being rigorously obeyed in a number of well-established cases. And it is hoped that the anomalies may yet be reduced to some kind of order. E. H. B.

545. *Theory of Extinction in Gases.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. pp. 915–941, Dec., 1909. Extract.)—If e and m are charge and effective mass of an electron, c the speed of light, the expression $2e^2/3mc^3=\theta$ is a definite and very short period of time. The equation of a vibrating electron is then written—

$$\ddot{\xi} - \theta\dddot{\xi} + n_0^2\xi = e/m\,.\,(\mathrm{E} + \omega\mathrm{P}),$$

where ξ is the displacement, n_0 the natural frequency, E and P the electric force and polarisation, and ω is a numerical factor not much different from $4\pi/3$. On this basis the index of extinction is then calculated. The results do not support Lorentz's theory of extinction. A few of the numerical values calculated for air are as follows, taking for N the value $2{\cdot}88 \times 10^{-19}$ cm.$^{-3}$. For comparison those from the experiments of Abbot and Fowle are given.

Wave-length λ.	Indices of Extinction.	
	Natanson's Calculation.	Abbot and Fowle's Experiments.
4·210	10·85	10·95
4·343	9·85	9·55
4·666	7·86	7·89
5·889	3·84	5·72

E. H. B.

546. *Binocular Vision.* **A. Quidor.** (Annal. Chim. Phys. 19. pp. 233–288, Feb., 1910.)—Stereoscopic perception of the notions of distance and relief is due to the psychic synthesis of the images perceived. It is, in consequence, not governed by the precise laws of orthostereoscopy. It is characterised by the necessity for accommodation and convergence for different distances, and depends on the divergence of the visual axis. A law applicable generally in stereoscopy is enunciated, viz., that retinal images of an object are always of unequal size. The relief is stereoscopic when, for objects at the left of the observer, the larger image is seen by the left eye, and similarly for the right eye. An inverse disposition of the images gives pseudoscopic relief. By the aid of principles established by means of the Quidor-Nachet microscope, and by using the notions of absolute and relative relief, the influence of certain binocular instruments on relief is determined, the results not agreeing with those given by Fechner's law. The unity of sensation appears to be due to a particular structure of the visual apparatus. G. E. A.

547. *Chromatic Construction.* **A. Rosenstiehl.** (Comptes Rendus, 150. pp. 350–352, Feb. 7, 1910.)—It is known that the mixture of two coloured sensations not complementary produces some white and a third colour. The quantitative examination of the phenomenon shows that the intensity of this third colouration is always below the mean of those of its two components. The quantitative aspect of this case is here dealt with by means of a geometrical construction involving an equilateral triangle, an inscribed circle which is the base of a cylinder, and a cone which passes through the top face of this cylinder and whose base circumscribes the triangle. [See also Abstract No. 386 (1910).] E. H. B.

548. *Extinction of Colour by Reduction of Luminosity.* **W. de W. Abney.** (Roy. Soc., Proc. Ser. A. 83. pp. 290–297, Feb. 10, 1910.)—At a very low luminosity the eye cannot perceive colour. In the present investigation the author seeks to ascertain the extent to which the luminosity in different regions of the spectrum must be reduced in order that the colour-sensation may disappear. He describes in detail the apparatus used in these researches and presents curves and tables connecting the wave-length of the light studied, and the necessary reduction in luminosity. Attention is drawn to the fact that a sharp peak in the curve occurs near $\lambda = 0{\cdot}5772\,\mu$, which is where the red and green sensation-curves of equal stimulation cut each other. In conclusion, the author suggests that the results of these investigations are in favour of the three-sensation theory of colour-vision and opposed to those theories involving the assumption that sensations go in pairs. J. S. D.

549. *Pleochroic Halos.* **J. Joly.** (Phil. Mag. 19. pp. 327–330, Feb., 1910.)—The examination of a section of greisen from Altenburg, Saxony, shows some pleochroic halos of peculiar appearance. There is an inner and an outer halo of very different densities; so that an inner darker sphere and an outer less deeply coloured shell are clearly indicated. In the field the central dark area is fairly uniform save along the outer margin, where it diffuses rapidly, being immediately succeeded by an area, fading somewhat—almost imperceptibly—outwards, but wonderfully sharply defined at the extreme boundary. The radial width of this corona is about one-half the radius of the inner disc. The measurements obtained show that the radii of the halo and its corona are 0·022 mm. and 0·034 mm. respectively. Calculations based on the different penetrating powers of the α-rays from the Ra family show that if these halos are due to those α-rays then the radius of the halo should be 0·0230 mm., and that of the corona 0·0337 mm.—numbers which are in close agreement with those obtained by direct measurements. The reason why all pleochroic halos due to Ra do not show this corona is probably because in very old halos, or halos due to very active nuclei, the structure becomes obliterated. The effects of the more intense inner ionisation probably reach a maximum, or at least do not continue to visibly increase at the initial rate. Finally, the effects in the corona must accumulate till there is sensible equality in density. These complex halos evidently contain no effective quantity of Th, for the α-rays given off by the Th family would, on account of their greater penetrating power, obliterate the structure observed. The very marked outer boundary of the corona appears to favour the view so clearly appearing in Bragg's curves, that the ionisation of the α-ray increases in intensity just before it becomes finally ineffective. That the effects visible in the halo are due to ionisation, and not to mere storage of He, appears to be set beyond doubt by the observed limit of the rays in mica agreeing with the observations on the ionisation ranges as obtained in the laboratory. A mere accumulation of He should exhibit considerably larger radial dimensions. [See also Abstract No. 818 (1907).] A. E. G.

550. *Resonance and Magnetic Rotation Spectra of Sodium Vapour Photographed with the Concave Grating.* **R. W. Wood** and **F. E. Hackett.** (Astrophys. Journ. 30. pp. 339–372, Dec., 1909.)—The resonance and magnetic rotation spectra of Na have been photographed with a 12-ft. grating with 14,488 lines to the inch. The method of observation was essentially the same as in previous papers. The main object was to investigate whether the spacing of the lines in the resonance series is truly one of equal wave-lengths. This has now been found to be the case, but the intervals are not absolutely constant, the variations being greater than experimental error. These variations from constancy the authors attribute to some form of disturbance, possibly absorption effects. More than one resonance series is frequently given by one and the same exciting line. E. C. C. B.

551. *Emission and Absorption of Spectral Lines.* **R. Ladenburg.** (Deutsch. Phys. Gesell., Verh. 12. 2. pp. 54–80, Jan. 30, 1910.)—The experimental arrangement is essentially as follows: Along an axis lie the capillary emission tube, a lens, a Nicol prism, the absorption tube, a second nicol, a diaphragm, a second lens, and a Wanschaff spectrometer with a Rowland plane grating. The two tubes are connected to a drying vessel, the hydrogen-producing apparatus and pump. The tubes also had electrodes, a pair in each, all four being in a circuit containing a capacity of 1/150 mfd. and an inductance of 2×10^{-5} henry, the capacity being charged to 18,000 volts by an induction coil. The effects obtained are shown by three photographs and discussed by the aid of curves plotted from theoretical formulæ. [See also Abstracts Nos. 76 and 1776 (1908).] E. H. B.

552. *Measurements in the Infra-red Region of the Spectrum.* **H. Rubens** and **H. Hollnagel.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 4. pp. 26–52, 1910.)—The authors have used a quartz interferometer designed like Michelson's instrument, and observed the energy-curves with rock-salt, sylvin, KBr, and KI. The rays from a source such as an incandescent gas mantle are focussed upon the interferometer and the emergent rays are successively reflected from four polished surfaces of the substance and then focussed by a second mirror upon a radiomicrometer. The energy curves are drawn by plotting the throw of the radiomicrometer mirror against the thickness of the air layer in the interferometer. By analysis of these curves it is shown that the residual rays of rock-salt, sylvin, and KBr consist of two rays of different strengths, and that this may also be true in the case of KI. The wave-lengths of the rays are as follows (the stronger one being given first): rock-salt, 53·6 μ, 46·9 μ; sylvin, 62·0 μ, 70·3 μ; KBr, 86·5 μ, 75·6 μ; KI, 96·7 μ. The absorbing and reflecting powers of various media for each of these rays were also measured and, further, it was found that the refractive index of H_2O for $\lambda = 82{\cdot}8\,\mu$ is of the same order as in the visible spectrum. E. C. C. B.

553. *Effect of a Magnetic Field upon the Absorption Spectra of Rare Earths.* **W. F. Schultz.** (Astrophys. Journ. 30. pp. 383–397, Dec., 1909.)—The absorption spectra were observed by examining the beam from an electric arc or some other source after reflection from a surface of the fused oxide. The oxides of Er and Nd were especially examined, the observations being made both parallel and perpendicular to the lines of force. It was found that practically no difference was observable between the two methods. The changes produced by the field are detailed in the paper. Certain bands are unaffected, while others are shifted, some towards the red and some towards the violet. A number of bands were found to be unsymmetrically broadened, the broadening being in some cases greatest towards the red, and in other cases towards the violet. The intensity of the bands is altered in the field, and some of them disappear. E. C. C. B.

554. *Effect of Temperature on Fluorescence and Absorption.* I. *Fluorescence and Absorption of Canary Glass at High Temperatures.* **R. C. Gibbs.** (Phys. Rev. 28. pp. 861–876, May, 1909.)—The effect of temperature upon the fluorescence and absorption of a block of uranium glass was studied, and it was found that increase of temperature produces an increase in the absorption and a widening of the absorption band. The typical fluorescence for the larger fluorescence band in the yellow-green shows, with increase of temperature, a slight shift towards the red. The changes in the typical fluorescence seem to indicate that this band consists of two or more overlapping bands which are affected differently by temperature. The intensity of fluorescence is somewhat greater immediately after cooling than before heating. It gradually returns to the normal value. E. C. C. B.

555. *Studies in Luminescence.* IX. *A Spectrophotometric Study of certain Cases of Kathodo-luminescence.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 28. pp. 849–860, May, 1909.)—In this paper the authors deal with the luminescence produced by kathode rays upon $CdSO_4$ (with some $MnSO_4$), Willemite and Sidot blende, using a Holtz influence machine. They find that the distribution of intensity throughout each band of the luminescence spectrum is independent of the discharge potential and, therefore, of the velocity of the kathode streams. In cases where a band can be excited by light and by Röntgen rays as well as by kathode rays, the form of the band and the position of its maximum are the same for all these modes of excitation. Phosphorescence following excitation by kathode streams is less intense and more fleeting than that excited by light in the same substance. The effect of infra-red rays upon the kathodo-luminescence of Sidot blende is small compared with the effect upon the photo-luminescence, and it produces a barely observable decrease in the intensity of the luminescence. E. C. C. B.

556. *Luminescence.* III. *Deviations from Stokes' Law.* **J. de Kowalski.** (Acad. Sci. Cracovie, Bull. 1A. pp. 12–16, Jan., 1910.)—In discussing his theory of luminescence [Abstract No. 68 (1909)], the author showed that, in consequence of the deviations from Stokes' law, it must be assumed that the kinetic energy of the free electron is less than that it obtains by liberation from the electronogen owing to the absorption of the corresponding light-quantum [compare Einstein, Abstract No. 909 (1909)]. It is assumed that this deficiency is supplied by the energy of molecular movement, so that every cause which alters the kinetic energy of molecular motion in a definite way should produce a corresponding alteration in the value of the deviation from Stokes' law. The author has, therefore, investigated the influence of change of temperature on the deviation from Stokes' law with an alcoholic solution of Kahlbaum's rhodamine, which solidifies at the temperature of liquid air to a solid solution—no part of the dissolved substance separating out. Investigation of the green fluorescence of the solution at 18–20°, and at −185° confirms the above assumptions. On the basis of the Planck-Einstein light-quantum theory, the difference between the energies corresponding with the just perceptible kinds of light at the two temperatures of observation can be calculated. In this way, the value of Boltzmann's universal constant is found to be $K = 7{\cdot}5 \times 10^{-17}$, which is in satisfactory agreement with the number, $6{\cdot}5 \times 10^{-17}$, calculated by Einstein by means of the kinetic theory of gases. T. H. P.

557. *Luminescence.* IV. *Absorption and Phosphorescence of Certain Organic Compounds.* **J. de Kowalski.** (Acad. Sci. Cracovie, Bull. 1A. pp. 17–22, Jan., 1910.)—Photographs of the phosphorescence-spectra of solutions of a large number of aromatic organic compounds in alcohol show that the spectra consist of band-spectra on a continuous ground. The continuous spectrum is very strong in the first moment, but diminishes very rapidly in intensity, whilst the band-spectrum diminishes more slowly. The results are given of 0·05 per cent. solutions of benzene, toluene, ethylbenzene, and para-xylene in alcohol. With benzene, the phosphorescence spectrum consists of a faint, continuous foundation on which appear six distinct double bands and two fainter double bands, the wave-lengths being: 439–429, 419–413, 402–397, 385–380, 371–365, 357–352, 346, and 339. When the frequencies are calculated corresponding with the middle of each of these phosphorescence bands, and the same is done for the absorption bands, it is found that the differences between the corresponding numbers of the two series are approximately constant and equal to 140. Similar results are obtained for toluene and ethylbenzene—the phosphorescence spectra for which differ but slightly from one another—and for *p*-xylene. It is hence concluded that, for these aromatic compounds, to each absorption band corresponds a phosphorescence band which, for one and the same substance, differs from the first by a constant frequency. T. H. P.

558. *Restoration of Phosphorescent Properties to Sulphides of the Alkaline Earths.* **D. Gernez.** (Comptes Rendus, 150. pp. 295–300, Feb. 7, 1910.)—Under the prolonged influence of air and water, calcium and strontium sulphides, and probably also barium sulphide, gradually lose their phosphorescent properties. Experiments on samples of these sulphides which have been kept in loosely-stoppered vessels for a number of years show that they regain the property of showing vivid phosphorescence if they are heated in a current of hydrogen for about 20 min. at a temperature sufficient to soften Bohemian glass. T. H. P.

559. *Rays emitted by Metals of the Potassium Family.* **E. Henriot.** (Le Radium, 7. pp. 40–48, Feb., 1910. From the Laborat. de Physique de l'École Normale Supérieure, Paris.)—The paper deals in the main with a detailed investigation of the rays given off by potassium salts. The author shows that potassium gives off β-rays without emanation or α-rays. Attempts to separate the radio-activity from the potassium were unsuccessful. Salts of rubidium gave results analogous to those of potassium, the radiation being greater, however, but less penetrating. Cæsium, sodium, lithium, and thallium were found to be inactive. E. M.

560. *Penetrating Radiation.* **P. Wulf.** (Annal. Soc. Sci. de Bruxelles, 34. 1. pp. 119–186, 1909–1910.)—The author has made observations with his bifilar electrometer on the very penetrating radiation observed in the air. Experiments were carried out in various caves and mines, and also, amongst other places, at the surface of different ponds and lakes. The observations lead to the following conclusions: (1) The penetrating radiation is caused by

radio-active substances which are situated in layers of the earth at a higher level than about 1 m. under the surface. (2) The part of the radiation which has its origin in the atmosphere is so small that it is impossible to prove it with the means used. (3) The oscillations in the γ-radiation may be explained by the displacement of masses of air more rich in emanation contained in the interior of the earth at spots more or less deep. J. J. S.

561. *Ionisation of a Molecule by an α-Particle.* **R. D. Kleeman.** (Roy. Soc., Proc. Ser. A. 83. pp. 195–199, Jan. 7, 1910.)—Experiments were made to determine the source of the energy which appears when ionisation takes place. A method was devised in which the ionisation produced by secondary corpuscular radiation was magnified to such an extent that the distribution of these radiations could be investigated with some ease notwithstanding the ionisation of the gas by the α-particle. It was found that more electrons are emitted in the direction in which the ionising α-particles are travelling, or that the resultant momentum of the electrons is in the same direction as that of the α-particles. The experiments therefore support the view that all or part of the momentum of the electrons emitted, when ionisation by α-particles takes place, is derived from that of the α-particles. J. J. S.

562. *Rate of Evolution of Heat by Pitchblende.* **H. H. Poole.** (Phil. Mag. 19. pp. 314–326, Feb., 1910.)—The method and experimental arrangements adopted are fully described. The various sources of error, such as possibility of chemical action and irregularities in the temperature of the ice used, are also discussed. The results obtained lead to the conclusion that each gm. of pitchblende evolves $6{\cdot}1 \times 10^{-5}$ cal. per hour—an amount much higher than might be expected. An analysis of a sample of the pitchblende used indicates the presence of 64 per cent. of Ur. Now, according to Boltwood, each gm. of Ur in equilibrium is associated with $3{\cdot}4 \times 10^{-7}$ gm. of Ra, and since the accepted value for the rate of evolution of heat by Ur and products in equilibrium with 1 gm. of Ra is $5{\cdot}6 \times 10^{-2}$ cal. per sec., each gm. of pitchblende should only evolve $4{\cdot}4 \times 10^{-5}$ cal. per hour. It is hoped to repeat the experiment in a slightly modified form, using a solid block of pitchblende.

A. E. G.

563. *Deposit of the induced Radio-activity of Radium.* **A. Debierne.** (Le Radium, 6. pp. 97–106, April, 1909.)—The manner in which the induced activity is deposited on sheets of metal in the absence of an electric field has been studied. The deposit does not take place as might be expected, and there is a great difference between the theoretical curve and that obtained from experiment. This discrepancy may be due to the influence of concentration; as this increases there is probably an augmentation of the size of the particle of induced activity, which diminishes its rate of diffusion. The change in the particles may also render them non-absorbable by the sheets, perhaps owing to the loss of electric charge on account of the increased number of ions in the gas when the concentration in emanation increases. The mechanism of the deposit of induced radio-activity appears to be somewhat complicated. J. J. S.

564. *Half-life Period of Radium.* **R. W. Gray** and **W. Ramsay.** (Chem. Soc., Journ. 97. pp. 185–186, Feb., 1910.)—A correction is made in the value given for the half-life period of radium in a previous paper

[Abstract No. 1634 (1909)]. The true half-life period should have been calculated from the equation, $R = R_0 e^{-\lambda t}$, where R is the initial amount of radium, R_0 the quantity remaining after half has decayed, e the base of natural logarithms, λ the disintegration constant for Ra (the reciprocal of which is the average life-period), and t the time in years. Hence the half-life period for Ra is 1744 years, or 1 gm. of Ra will have been reduced to 0·5 gm. after 1744 years. J. J. S.

565. *Emanation from Radium Salts at different Temperatures.* **L. Kolowrat.** (Le Radium, 6. pp. 321–327, Nov., 1909.)—In previous experiments [see Abstract No. 1651 (1907)] the author has shown that the amount of emanation given off by solid barium chloride containing Ra varies in an anomalous way with the temperature. He now explains this by Plato's result [see Abstract No. 1444 (1909)] that barium chloride undergoes a molecular modification at 34·4° below its fusion temperature. Further experiments are described, showing that in the same chemical and physical state of a radium salt at a given temperature the quantity of emanation absorbed by the salt is the same whether or not the temperature in question has been kept up since the commencement of the accumulation of the emanation. Experiments were made on different salts. E. M.

566. *The Decay of Radium Emanation.* **Mme. P. Curie.** (Le Radium, 7. pp. 33–38, Feb., 1910).—Different values of the period of RaEm made by various observers disagree by several per cent., and the present paper describes experiments undertaken for its exact determination. The method used was that of observing the activity produced by emanation sealed in a closed tube. In one series of experiments the measurements were made of the ionisation produced in the interior of the vessel containing the emanation, while in another series the measurements were made of the ionisation produced by the penetrating radiation in a chamber exterior to the tube of emanation. The measurements were in all cases made by a quartz piezo-electric, this method being independent of capacity or of the sensitiveness of the electrometer. Observations were made for periods up to 1000 hours, and the mean values of the decay constant given by the two series of experiments agreed within less than 1 per cent. In the series of experiments made of the ionisation produced in the interior of the emanation vessel it was found that there was some irregularity between 4 hours and 20 hours, the decay being then somewhat quicker than later on. The rate of decay was found to be independent of the concentration within very wide limits, and the mean values found were—

$$\lambda = 2·085 \times 10^{-6}\ \text{sec.}^{-1} = 0·00751\ \text{hour}^{-1}.$$

$$T = 3·324 \times 10^{5}\ \text{sec.} = 92·34\ \text{hours} = 3·85\ \text{days}.$$

E. M.

567. *Polonium.* **Mme. P. Curie** and **A. Debierne.** (Comptes Rendus, 150. pp. 386–389, Feb. 14, 1910. Chem. News, 101. pp. 85–86, Feb. 25, 1910. Le Radium, 7. pp. 38–40, Feb., 1910.)—Several tons of the residue of uranium ore yielded about 200 gm. of impure matter containing polonium. The present paper describes the purification of this to obtain a very concentrated preparation of polonium. An investigation of the spark spectrum of this preparation gave lines attributed to polonium. The authors intend to re-examine the spectrum when the polonium has decayed, with the hope of finding the product produced by its transmutation. Part of the polonium

preparation was used for the study of the He produced by its transformation. This He was collected and measured, and its quantity was found to be in good agreement with that predicted by theory. E. M.

568. *Adsorption of Uranium X by Barium Sulphate.* **A. J. Berry.** (Chem. Soc., Journ. 97. pp. 196–200, Feb., 1910.)—Becquerel has shown [see Abstracts Nos. 2166 (1900) and 460 (1902)] that when barium is precipitated as sulphate in a uranium solution the photographic activity of the latter is removed by the barium sulphate: this activity is due to UrX. The adsorption of UrX has now been investigated quantitatively, and evidence obtained of a definite partition coefficient between the UrX in the barium sulphate and in the solution. E. M.

REFERENCES.

569. *Optical and Mechanical Relaxation Time.* **R. Reiger.** (Ann. d. Physik, 31. 1. pp. 93–97, Dec. 30, 1909.)—Cases are discussed in which the mechanical and optical relaxation time are not identical. Experiment shows that it must not be assumed without further inquiry that a conclusion can be reached as to the value of the optical relaxation time from that of the mechanical. J. J. S.

570. *Theory of Aberration and Principle of Relativity.* **H. C. Plummer.** (Roy. Astronom. Soc., M.N. 70. pp. 252–266, Jan., 1910.)—In a former paper the author has discussed the application of the theory of aberration in connection with modern optical theory [Abstract No. 1509 (1909)]. The hypothesis developed by Lorentz and embodied in the principle of relativity is put forward to explain several of the experimental results which cannot be reconciled with the ordinary theory. The chief of these is the Michelson-Morley investigation of the relative motion of the ether and the earth. The new law is developed analytically, and the developments of modern physical theory emphasised which intimately concern the problems of astronomical movements. C. P. B.

571. *Thermodynamics of Diffraction.* **M. Laue.** (Ann. d. Physik, 31. 3. pp. 547–558, March 1, 1910.)—Shows on thermodynamic grounds that diffuse reflection and refraction, as also the scattering in turbid media, are irreversible phenomena. [See Abstract No. 2075 (1909).] E. H. B.

572. *The Flicker Photometer.* **J. S. Dow.** (Electrical World, 55. pp. 465–469, Feb. 24, 1910.)—The author discusses the theory of the flicker photometer, dwelling at length on the purely physiological aspect of the question. [See Abstract No. 796B (1909).] A. R.

573. *Spectrum of Calcium given by the Oxy-Acetylene Flame.* **G. A. Hemsalech and C. de Watteville.** (Comptes Rendus, 149. pp. 1112–1115, Dec. 13, 1909.)—A description of the spectrum of Ca as obtained by the authors' method with the oxy-acetylene flame. The spectrum resembles that of the arc, and 26 lines are given with their wave-lengths. [See Abstract No. 1342 (1907).] E. C. C. B.

574. *Radio-activity.* **C. E. S. Phillips.** (Röntgen Soc., Journ. 6. pp. 1–14, Jan., 1910. Presidential Address.)—A general survey of some recent work on radio-active phenomena is given, and also details of experiments on the estimation of radio-activity by expressing it in terms of the saturation current produced by the passage of rays through air under atmospheric pressure. Observations were made both with an electrometer and a gold-leaf electroscope. J. J. S.

575. *The Absorption Law of β-Rays.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 10. pp. 948–950, Dec. 1, 1909.)—A criticism of the results obtained by W. Wilson. [See Abstract No. 1888 (1909).] A. E. G.

576. *Contribution to our Knowledge of the Sodium Spectra.* **H. Zickendraht.** (Ann. d. Physik, 31. 2. pp. 233–274, Jan. 28, 1910. Habilitationsschrift, Basel.)—A complete study of the spectra of Na as obtained with the arc and the spark with and without a condenser and self-induction, under various pressures. E. C. C. B.

577. *Wave-length Measurements in the Visible Region of Spark Spectra.* **J. M. Eder** and **E. Valenta.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1077–1100, July, 1909.)—A continuation of the author's previous work [see Abstract No. 102 (1910)]. In this paper are given the measurements (Rowland) of the wave-lengths of the spark spectrum lines of air, Al, Sb, Ba, Pb, Cd, Ca, Cr, Au, In, Co, Mn, Mo, Ni, Ag, Sr, Ta, Te, Tl, Ti, V, Bi, W, Zn, and Sn. E. C. C. B.

578. *The High-temperature Flame Spectrum of Iron.* **G. A. Hemsalech** and **C. de Watteville.** (Comptes Rendus, 150. pp. 329–332, Feb. 7, 1910.)—The authors deal with the character of the iron spectrum given by the oxy-acetylene flame. A comparison with the arc spectrum of iron shows that the low-temperature lines are those present in the flame spectrum. E. C. C. B.

579. *Investigation of the Long Wave-length Region of the Titanium Spectrum.* **P. Fiebig.** (Zeitschr. wiss. Phot. 8. pp. 73–101, Jan., 1910.)—A measurement of the arc spectrum of Ti with a Rowland grating between the limits λ=7364 and λ=4203. Six series of lines were recognised in the spectrum. E. C. C. B.

580. *Anomalies in Reversal of Sodium Lines.* **W. Jacobi.** (Deutsch. Phys. Gesell., Verh. 12. 1. p. 5, Jan. 15, 1910.)—A note recording the observation of anomalous occurrence of the reversal of the D line. G. E. A.

581. *Absorption Spectra of various Salts in Solution and Effect of Temperature upon such Spectra.* **H. C. Jones** and **W. W. Strong.** (Amer. Chem. Journ. 43. pp. 37–90, Jan., and pp. 97–135, Feb., 1910.)—A complete account of the absorption spectra of K_2CrO_4, $K_2Cr_2O_7$, $K_4Fe(CN)_6$, $K_3Fe(CN)_6$, uranyl chloride, bromide, sulphate, and acetate, and of uranous salts. In the section dealing with the effect of temperature the absorption spectra of salts of Co, Ni, Cu, Cr, U, Pr, and Er are dealt with. Full curves are reproduced of the absorption spectra obtained. E. C. C. B.

HEAT.

582. *Hydrostatic Compensation Method for Measurement of Thermal Expansion.* **M. Bellati and L. Finazzi.** (N. Cimento, 18. pp. 432–438, Nov.–Dec., 1909.)—A method is described for the more accurate measurement of thermal expansion, the expansion of the substance under examination being as nearly as possible counterbalanced by the expansion of another body of which the coefficient of expansion is known, and special precautions being taken to obviate errors due to change of temperature, condensation of liquid on the suspending wire, &c. Figs. 1 and 2 explain the arrangement, the first showing how by the use of Al triangles the copper wires A and B are brought close together. These pass through a metal tube C, which protects them from air currents, and beneath this they are connected to Pt wires, from which are suspended two glass tubes immersed in the liquid, these containing the substance under examination and the standard substance respectively. The tube *e* allows the vapour from the liquid to be aspirated off, at the same time causing a current of air to pass through the tubes *f*, *f*. The temperature is maintained electrically, and the whole is contained in a Dewar vacuum vessel. Very good results have been obtained with the method, even at temperatures above 200° C. W. H. Sı.

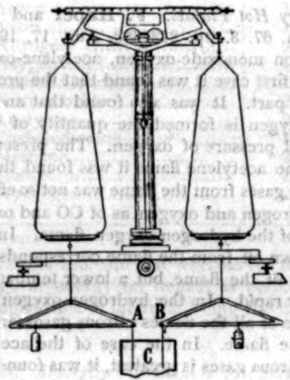


Fig. 1.

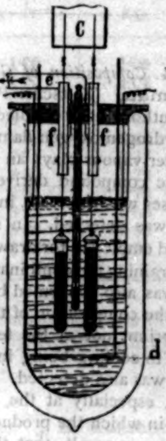


Fig. 2.

583. *Expansion of Fused Quartz at High Temperatures.* **H. M. Randall.** (Phys. Rev. 30. pp. 216–235, Feb., 1910.)—An earlier piece of work [see Abstract No. 278 (1907)] is repeated with great care. The method is improved to give more accurate results; the specimen of quartz is the same. For an account of the method see Abstracts Nos. 640 (1903) and 550 (1905)]. The thermostat used is an improvement of one described by Darwin. A Pt—Pt-Rh couple is used to measure the temperature. An irregularity noticed by previous experimenters, probably due to air-films at the points of contact, was removed by exhausting the oven of air and working at a pressure of 0·05 mm. The mean coefficient α, between 16° C. and any temperature θ up to 1000° C., is given in the following table:—

θ.	$\alpha \times 10^8$.	θ.	$\alpha \times 10^8$.
200	51·8	700	56·0
300	54·6	800	54·6
400	56·4	900	53·8
500	56·8	1000	54·3
600	56·6	1100	53·5

T. P. B.

584. *Composition of Gases in very Hot Flames.* **F. Haber** and **H. J. Hodsman.** (Zeitschr. Phys. Chem. 67. 3. pp. 343–383, Aug. 17, 1909.)—The authors have studied the carbon monoxide-oxygen, acetylene-oxygen, and hydrogen-oxygen flames. In the first case it was found that the presence of water-vapour plays an important part. It was also found that an endothermic compound derived from oxygen is formed, the quantity of which increases with increase in the partial pressure of oxygen. The presence of ozone was detected. In studying the acetylene flame it was found that the method employed for drawing off the gases from the flame was not so efficient in restraining the combination of hydrogen and oxygen, as of CO and oxygen. This was also confirmed by a study of the hydrogen-oxygen flame. In such cases the composition of the gas drawn off from the flame corresponds to an equilibrium not at the temperature of the flame, but a lower temperature, owing to cooling being insufficiently rapid. In the hydrogen-oxygen flame ozone was also detected. In the case of all the flames nitrous gases are produced, especially at the edge of the flame. In the case of the acetylene flame, in which the production of nitrous gases is greatest, it was found, as a preliminary result, that the nitrous gases amounted to about 4 volumes to 100 volumes of CO_2. As regards the temperature of the flames, the carbon monoxide flame is the coldest, the acetylene flame the hottest, the temperatures being 2600° for the former and probably over 3000° for the latter. The temperature of the hydrogen-oxygen flame may be placed at 2800° to 2900°. The authors believe that in the case of flames with a temperature of 2500° and upwards *electric* dissociation is of especial importance for the understanding of the chemical relationships. [See also Abstract No. 1476 (1909).] A. F.

585. *Conduction of Heat through Rarefied Gases.* **F. Soddy** and **A. J. Berry.** (Roy. Soc., Proc. Ser. A. 83. pp. 254–265, Feb. 10, 1910.)—An investigation has been made of the conduction of heat through twelve gases at pressures so low that the actual path of the molecule is comparable with its mean free path. The principle of the method employed was to maintain a bright Pt strip, stretched through a long, narrow tube containing the rarefied

gas, at a constant temperature, found subsequently to be 61°, by means of a varying current. The strip formed one arm of a Wheatstone bridge. The heating current was adjusted until balance was obtained. By means of potential leads fixed to the strip the fall of potential across the strip was then immediately measured by means of a potentiometer. The resistance of the strip being constant, the heat dissipated by the portion of the strip between the potential leads is proportional to the square of the p.d. across them. The conductivity of a gas at low pressure may be defined as the number of calories dissipated by the gas per sec. per 0·01 mm. pressure, per cm.^{2} of hot surface, per 1° difference of temperature between the hot surface and its surroundings. The value of the conductivity deduced from the experimental results is denoted by K and the value calculated from the kinetic theory of gases by Q. No great accuracy is claimed for the values found at present. The following table gives the values of K and Q and the ratio of these two quantities in the case of various gases :—

	K($\times 10^{-5}$).	Q($\times 10^{-5}$).	K/Q.
Argon	1·30	1·20	1·09
Neon	1·76	1·70	1·04
Nitrogen	2·21	2·35	0·94
Oxygen	1·91	2·23	0·86
Carbon monoxide	1·96	2·38	0·82
Nitrous oxide	2·11	2·75	0·77
Acetylene	2·75	3·82	0·72
Carbon dioxide	1·89	2·64	0·72
Methane	2·70	3·95	0·68
Helium	1·94	3·80	0·51
Hydrogen	2·29	8·95	0·25

The results indicate that whereas for the denser monatomic gases the interchange of energy on impact is perfect, for the lighter gases, helium and hydrogen, this is far from being the case. J. J. S.

586. *Absorption of Liquids by Porous Substances.* **J. H. Russenberger.** (Comptes Rendus, 150. pp. 275–278, Jan. 31, 1910.)—The absorption of water by sponge, sawdust, blotting-paper, and cotton when immersed therein, has been measured at different temperatures, and it is concluded that between certain limits the specific absorptive power, X, of a substance $= p/Qs \, . \, dh/dt = h/Q \, . \, dh/dt$, s being the cross-section of the substance immersed, h the height of the water in contact with it, p the weight of water absorbed, t the time, and Q the weight contained in unit volume of absorbent. The absorptive power varies for different substances, and, for cotton, is proportional to the cross-section immersed. It is constant between certain limits, whatever the height of the water, and increases considerably with rise of temperature. Analogous experiments by Goppelsroeder with blotting-paper and a large number of different liquids, have given results which verify the author's conclusions, and show that the absorptive power of blotting-paper diminishes gradually for volatile liquids, and rapidly for less volatile liquids. The same results are obtained with absorbent substances, which are eventually dissolved in the liquid absorbed. W. H. Si.

587. *Electron Theory of Thermal Radiation.* **J. Kunz.** (Phys. Rev. 28. pp. 318–323, May, 1909.)—The author starts from J. J. Thomson's expression for the energy of frequencies between p and $p + dp$ radiated from unit volume of a conductor in unit time [see Abstract No. 1545 (1907)], which contains an undetermined function $f(t)$ representing the acceleration of an electron in the neighbourhood of an atom as a time function. He then determines this function by the condition that Planck's formula for the distribution of energy in the spectrum of the radiation from a black body should reduce to the form obtained by Wien for small values of λT and for visible light. Conclusions relative to the nature of the motion during a collision are then deduced from the result. [The analysis involves (1) the employment of Thomson's formula for electric conductivity for waves of frequency p, which Jeans has shown to be incorrect (see Abstract No. 1268 of 1909). (2) The assumption that the second law of thermodynamics may be applied to radiation problems, which Jeans has shown to be illegitimate (see Abstract No. 1698 of 1905).] G. W. de T.

REFERENCES.

588. *Gaseous Explosions.* (Brit. Assoc. Report, pp. 308–341, 1908. First Report of B.A. Committee.)—The full Report corresponding to Abstract No. 1156b (1908).

589. *Temperature of Superheated Vapour.* **J. B. Fournier.** (Comptes Rendus, 150. pp. 521–524, Feb. 28, 1910.)—Discusses the best position for the thermometer in engines driven by superheated vapours to obtain the true temperature of the latter. G. E. A.

590. *Le Chatelier-Braun's Principle and Thermodynamic Laws of Reciprocity.* **P. Ehrenfest.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 8. pp. 347–364 (Physical Part), 1909.)—A mathematical paper dealing with the criteria necessary for the application of the le Chatelier-Braun principle in each separate case in such a way that the effect shall have the true, and not the reverse, sign. T. H. P.

SOUND.

591. *Phonometer.* **P. Lebedev.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 9. pp. 870–872, 1909.)—It has been shown by Zernov [Abstract No. 1128 (1908)] that a Rayleigh disc affords a reliable means of measuring the absolute intensity of sound, and may be employed successfully for measuring the intensity of the human voice. On the same principle the author has devised a phonometer—the construction being described in detail—which exhibits considerable sensitiveness, is aperiodic, and requires no particular precautions for its transport; it allows of the comparative measurement of the intensities of sounds, or, if its indications are previously compared with those of a Rayleigh disc, of absolute measurements. In a large hall it shows readily the comparative intensities of the sounds of different instruments, and also the distribution of the intensities of sound in a scale sung or played on a wind instrument. T. H. P.

592. *Speeds of Sound and Ratios of Specific Heats in Gases and Vapours.* **A. Lechner.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1035–1046, July, 1909.)—Each of the substances whose vapours were to be dealt with was contained in a glass tube with sharp edges, and placed in a bath of suitable temperature so as to give off the vapour filling the tube. The tube was then gently blown, and the frequency of the note obtained by the help of a monochord. The ratio γ of the specific heats of the vapours was then calculated, the density and temperature being known. The following are the chief results:—

Vapour.	γ.	Vapour.	γ.
H_2C_6O	1·15	Isobutyric Acid...	1·09
$C_4H_{10}O$..................	1·10	I	1·35
$C_5H_{12}O$..................	1·24	CCl_4	1·17
C_6H_6......................	1·14	CH_3OH	1·28
$C_4H_8O_2$..................	1·20	$C_3H_6O_2$..............	1·18
$C_8H_{16}O_2$	1·36	Hg	1·64
$C_4H_{10}O$..................	1·25	CS_2	1·26
$(CH_3)_3C(OH)$	1·26	$C_5H_{10}O$................	1·31
Acetic Ether	1·30	$C_9H_{18}O_2$	1·06

[See also Abstract No. 1472 (1904).] E. H. B.

593. *Stability and Limiting Condition of Sound.* **G. Ercolini.** (N. Cimento, 19. pp. 44–51, Jan., 1910.)—Experiments have been made with a Galton whistle, fixed in a resonance tube, vibrations being produced by compressed oxygen at known pressures. Tables are given, showing the corresponding values of T the length of the tube, I the size of mouth of the whistle, N the frequency of vibration, and H the minimum pressure necessary to produce it; and it is concluded that when the whistle is maintained in constant vibration, it gives simple sounds which are stable when sufficiently low; slowly increasing the pressure of gas, the sound produced gradually becomes more acute until it reaches the limit of audibility, the pressure necessary to cause this increasing rapidly with the wave-length of the fundamental sound. The minimum pressure to produce an audible vibration diminishes less quickly than the frequency of vibration of the sound thus obtained. W. H. Si.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

594. *Electronic Orbits.* **L. Silla.** (Accad. Lincei, Atti, 18. pp. 601–610, Dec. 19, 1909.)—Discusses the stability of the orbits constituting magnetic rays [see Abstract No. 674 (1909)]. This stability depends essentially upon the velocity of the electron, which attains a critical value at 10^8 cm./sec. For velocities below this binary combinations of ions and electrons are capable of existing, and their stability is increased by the presence of a magnetic field. Such "double-star" systems break up above the critical velocity. The author gives a treatment of the problem by means of elliptic integrals, fuller details of which are to appear elsewhere. E. E. F.

595. *Electronic Orbits.* **A. Garbasso.** (Accad. Lincei, Atti, 19. pp. 64–68, Jan. 16, 1910.)—An electron moves under the action of central forces. A magnetic field is established in a direction normal to its orbit, and the conditions are asked for under which the effect of the field will consist of a uniform rotation about the line of force passing through the centre of attraction. It is proved that this happens only when the force is proportional to the distance. When the orbit is elliptical, and a feeble magnetic field is established, the ellipse rotates in its own plane without deformation with the velocity $\mathrm{AH}e/2m$. E. E. F.

596. *Mass of Electrons.* **E. Hupka.** (Ann. d. Physik, 31. 1. pp. 169–204, Dec. 30, 1909. Extract from Dissertation, Berlin.)—In order to discriminate between Abraham's rigid (spherical) electron and Lorentz and Einstein's deformed electron (relativity theory), kathode rays were produced by photo-electric discharge and brought to a high velocity by letting them traverse a steep potential gradient. According to the sphere theory, the kinetic potential of an electron moving at speed q is—

$$-\frac{3}{4}\mu_0 c^2\left(\frac{c^2-q^2}{2qc}\log_e\frac{c+q}{c-q}-1\right),$$

while, according to the relativity theory, it is $-\mu_0 c^2[(1-q^2/c^2)^{\frac{1}{2}}-1]$, c being the velocity of light and μ_0 the mass of the electron when at rest. A beam of kathode rays traversing a certain range of potential possesses a greater speed and a greater magnetic deflectibility according to the sphere theory than according to the relativity theory. The difference is greatest for a p.d. of 820,000 volts if $q/c = 0{\cdot}884$. A p.d. of 75,000 volts would suffice to impart a velocity of $c/2$ according to the sphere theory, whereas the relativity theory would require 78,000 volts. The author obtained vacua capable of standing 90,000 volts by means of cocoa-nut charcoal and liquid air. With such potential gradients, velocities up to $c/2$ could be attained. This is not as high as that of the most rapid radium rays, but the kathode rays have the advantage of being more homogeneous. The results are in favour of the relativity theory rather than the sphere theory. The latter would require an experimental error of 1 per cent. to bring it within range of the data obtained, whereas the error did not exceed $\frac{1}{4}$ per cent. The author shows this by a lengthy discussion of the possible sources of error. The method of producing and maintaining accurately measurable p.d.'s of the order referred to is that devised by C. Müller. E. E. F.

597. *Nature of the Metallic Condition.* **E. Riecke.** (Zeitschr. Elektrochem. 15. pp. 473–484; Discussion, pp. 484–486, July 15, 1909. Paper read before the Deutsch. Bunsengesell, Aachen, May 24, 1909. Phys. Zeitschr. 10. pp. 508–519, Aug. 1, 1909.)—A summary of recent views on the electron theory of metals, on the basis of the "unitarian" principle that metals contain only one kind of movable electrons. Conduction, both electric and thermal, takes place by electrons only. Their free paths are probably many million times the diam. of a metallic atom, which itself is of the order of the diam. of a gaseous molecule. There is a mobile equilibrium between free and bound electrons within the metal, maintained by radiation and absorption of energy. The number of free electrons, N, per cm.^{3} is connected with that of total electrons U by the equation $N = U\epsilon^{-Q/Rt}$, where Q is the heat required to ionise 1 gm.-atom of electrons, *i.e.*, a number of electrons whose total mass equals the atomic weight of the electron (Königsberger), and $R = 8{\cdot}8 \times 10^7$. The author sketches the applications of the electron theory to (1) electric conduction, (2) thermal conduction, (3) thermo-electricity, (4) atomic magnitudes, and (5) the optical properties of metals. Electric conductivity is proportional to N, the density of free electrons, and to their free path L. The product NL must therefore diminish as the temperature rises. N most probably remains constant, and L must be regarded as inversely proportional to the square root of the absolute temperature. The reduced conductivity of mixed crystals is attributable to the conversion of free electrons into bound electrons. As regards thermo-electricity, the electronic treatment is analogous to that of concentration cells. Thermoelectric power is due to the differences of N for different metals, but the differences thus indicated are smaller than those indicated by the electric conductivities. The atomic radii range from 0·75 (Fe) to 1·40 (Bi and Sn). They vary periodically in the series of atomic weights, and such a periodicity is also recognised on calculating the radii from the density at melting-point, and assuming that at that point the atoms are in contact. In the *discussion*, **R. Schenck** announced his having obtained corroborative values of *p* (electrons per atom) from the conductivities of mixed crystals. **W. Nernst** advocated the recognition, in principle, of the existence of positive as well as negative electrons. **J. Stark** pointed out that there was no experimental evidence in favour of such recognition. E. E. F.

DISCHARGE AND OSCILLATIONS.

598. *Photo-electric Properties of Bodies and Electrification by Contact.* **N. A. Gezechus [Hesehus].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 7. pp. 312–318 (Physical Part), 1909.)—It has been pointed out by Elster and Geitel [Ann. d. Physik, 38. pp. 40 and 497 (1889), 44. p. 722 (1891)] and by Ramsay and Spencer [Abstract No. 330 (1907)] that, when arranged according to their photoelectric properties, the metals give a series corresponding with Volta's series, the most electro-positive metals being capable of manifesting the most intense photoelectric phenomena; these metals are also the softest. Since, with dielectrics, it is the hardest which assume positive contact electrification, it may be predicted that the same

dielectrics should exhibit considerable photoelectric properties. This prediction is confirmed by the results obtained with a number of minerals. T. H. P.

599. *Emission of Positive Rays from Heated Phosphorus Compounds.* **F. Horton.** (Cambridge Phil. Soc., Proc. 15. No. 4. pp. 329–333, Jan. 31, 1910.)—These experiments were carried out with the object of discovering whether there is any connection between the large positive ionisation produced by heating phosphates and the "anode rays" of Gehrcke and Reichenheim [see Abstract No. 845 (1908)]. No bright pencils so characteristic of the anode rays, are produced when aluminium phosphate or a mixture of sodium and lithium pyrophosphates with a little graphite is used as an anode of construction similar to that described by Gehrcke and Reichenheim. When, however, calcium phosphide is used as anode the pencil appears. It is probable that phosphorus vapour is present in this case owing to the decomposition of the phosphide when heated. There would thus be a large anode-fall and a strong force near the anode, which would give the liberated atoms the energy to make them luminous anode rays. The phosphates, on the other hand, are such very stable bodies that in their case there would be no phosphorus vapour to cause an abnormal anode-fall, and consequently no anode rays. Thus these experiments seem to confirm the view of Gehrcke and Reichenheim as to the origin of anode rays, and to show that there is no connection between this phenomenon and the emission of positive electrification from heated salts. A. E. G.

600. *Recombination of Ions at Different Temperatures.* **P. Phillips.** (Roy. Soc., Proc. Ser. A. 83. pp. 246–253, Feb. 10, 1910.)—In McClung's experiments on this subject it was suggested that diffusion would have a large effect and at the higher temperatures would account for most of the disappearance of the ions. The present experiments were carried out under such conditions that the diffusion could be neglected, though it is not quite negligible at the highest temperature attained. The values found for the coefficient of recombination, α, at different temperatures were :—

Temp. °C. ...	16	100	155	176	273
α	1·0	0·500	0·399	0·360	0·178

The number 0·178 for the last temperature is probably considerably too low, and the author estimates its proper value to be about 0·25. The curve giving the relation between α and the temperature shows that the recombination decreases somewhat rapidly with rise of temperature, but less rapidly as the temperature rises. J. J. S.

601. *Spark-gap Phenomena.* **J. McWhan.** (Roy. Soc. Edinburgh, Proc. 30. pp. 219–229, 1909–1910.)—The author records some puzzling phenomena which were observed during a research as to the cause of the Lullin-effect. This effect is shown when a thin plate of a dielectric is interposed between two electrodes which are not opposite to one another. In this case the plate is generally perforated opposite the negative electrode. If a dielectric plate be dropped vertically between the poles a violent discharge generally takes place, and it seems to occur more readily when the plate is thin and can be easily ruptured. Repulsion effects were observed on all kinds of plates when the electrodes were sparking freely. "Dark-space" phenomena are

described, and the breaking of bell-jars due to a discharge in a good vacuum. The conclusion is drawn that no theory yet advanced is capable of accounting for all the observed phenomena. A. R.

602. *Ionisation by Bubbles.* **L. Bloch.** (Comptes Rendus, 150. pp. 694–696, March 14, 1910.)—The paper deals with an investigation of the charge carried by the hydrogen produced by the action of hydrochloric acid on zinc. The total charge carried by the gas was measured, and it was found to be negative when the bubbles are very small, and positive when the bubbles are larger. The author also found that the charge on the gas is completely nullified when layers of foreign liquids are poured on to the acidulated water. E. M.

603. *Researches on Enveloped Electrodes.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 34. 1. pp. 111–117, 1909–1910.)—In the continued experiments [see Abstract No. 1742 (1909)] the author first unsuccessfully attempted to substitute a Bichat-Blondlot electrometer for the micrometer. The new series of potentials between the enveloped electrodes (glass bulbs containing liquid conductors) were determined in order to ascertain the cause of discrepancies in the results. The potentials of separate groups of experiments are in accord, though a gradual diminution of the width of the micrometer gap is sometimes noticed in a group, but the groups differ from one another. Changes in the air-pressure and in the humidity of the atmosphere do not explain the discrepancies, which may be due to a peculiarity of glass, as distinct from other dielectrics. H. B.

604. *Further Experiments on the Constitution of the Electric Spark.* **T. Royds.** (Phil. Mag. 19. pp. 285–290, Feb., 1910.)—The condensed spark between metallic electrodes was photographed upon a rapidly moving film with and without the interposition of a prism. Self-inductance ranging in value up to 0·034 henry was inserted in the circuit. The initial air-discharge is always present and instantaneous in character, and is simultaneous at all points of the spark-gap even when the period of the oscillation is increased to 2×10^{-4} sec. The discharges through the air which follow the initial one, and are of longer duration, are seen under certain circumstances to be subdivided even in a single half-vibration. The vaporisation of the metal is simultaneous with the initial discharge, and takes place equally at both electrodes, although after the first half-oscillation the metallic streamers are more intense at that electrode which is, for the instant, negative. The velocities of the metallic vapours have been measured from the slope of the first edge of the initial streamer, and are given in the paper. Self-inductance decreases the velocity, but this is probably due to a reduced temperature. Two simultaneous velocities in one and the same spectrum line are seen in the case of Ca. [See Abstract No. 1665 (1908).] E. C. C. B.

605. *An Electrical Tension Series in the Arc.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 729–734, June, 1909.)—If a direct-current arc be struck between electrodes, of which one is a solid carbon and the other a carbon with a copper core, it is found that when the double electrode is kathode, the arc is formed on the carbon, but that if the current be reversed, the arc is formed on the copper. This is explained by the supposition that when electrons leave a conductor, work must be done to overcome the force with which they are attracted to the conductor, just as in the case of surface

tension in the evaporation of a liquid. This force depends on the temperature, and on the nature of the conductor; when it is small, electrons will leave the conductor easily; when it is large, they will enter easily. Several double electrodes are investigated, consisting of small metal rods bound together, a carbon rod forming the other electrode, which latter is shown to be without influence on the phenomenon. The metals Al, Pb, Sn, &c., are too easily fusible, and Pt shows irregularities. It is, however, possible to establish the following series: Au, C, Ag, Cu, Fe, Zn—in order of attractive force, Zn showing the greatest. The order is the same as that of the electrode p.d.'s which give rise to e.m.f. in a galvanic cell. H. W. M.

606. *Acoustic Phenomena of Condensers.* **A. Righi.** (Le Radium, 7. pp. 4–8, Jan., 1910.)—The author thought that phenomena analogous to those of the singing arc of Duddell should be obtainable, if, for the arc, were substituted a vacuum tube or a flame. Both anticipations are verified, the former yielding the more striking results. The main circuit included a battery of 300 to 500 small accumulators, an adjustable resistance of copper sulphate solution, some coils to introduce inductance, and, finally, the vacuum tube. This was preferably arranged with a fine Pt-wire as anode placed vertically with its tip about 1 mm. above the surface of clean mercury which was the kathode. The second or shunt circuit, beside the vacuum tube, included a mica condenser of 0·05 to 1 mfd. capacity, some more inductances, and a telephone, which last, however, was seldom used. The paper then gives a mathematical theory of the phenomena. E. H. B.

607. *Radiation of a Rectilinear Oscillator in the Region of Short Electric Waves.* **M. A. Levitska.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 7. pp. 276–311; No. 8. pp. 327–346 (Physical Part), 1909.)—The author describes experiments on a rectilinear resonator excited by the field of a rectilinear vibrator. The results show that, when strongly damped, the resonator may exhibit maxima and minima of energy in the interference region of the waves of the vibrator. Observation of the resonance in different media affords a means of calculating approximately their dielectric constants. A rectilinear oscillator shows considerable sensitiveness towards a change in the medium in the neighbourhood of its centre. The wave-length and logarithmic decrement of the vibrations it performs are in moderate agreement with the theoretical magnitudes given by Abraham [Abstract No. 285 (1899)] for the fundamental vibrations. A rectilinear resonator in resonance with a rectilinear vibrator responds also to the overtone of odd order of the latter. The secondary radiation is far less intense than the primary radiation producing it, and, when there is resonance, the secondary radiation exhibits a phase-difference of π from the radiation incident on the resonator, and the true radiation of the latter is at a maximum. T. H. P.

608. *Wave-length and Overtones of a Linear Electrical Oscillator.* **J. E. Ives.** (Phys. Rev. 30. pp. 199–215, Feb., 1910.)—The oscillator chiefly used has a total length of 5 cm. The spark takes place in kerosene oil. The receiver is linear with thermo-couple at its centre. It is tuned to the oscillator by cutting off the copper wire, of which it is made, and noting the corresponding galvanometer deflections. The receiver being of resonant length, the common wave-length of oscillator and receiver is found by the interferometer method [see Abstract No. 281 (1898)]. The following results are of importance: (1) As the receiver is shortened from 30 cm. down to 2 cm.,

three well-defined maxima of deflections are obtained, viz., at 4·4, 18·8, and 25·7 cm. Thus at 4·4 cm. the period of receiver = that of oscillator, at 18·8 cm. it is three times that of oscillator, at 25·7 cm. it is five times. Therefore at 25·7 cm. the receiver is vibrating with an oscillation of the fifth order, and this overtone has the same frequency as the oscillator. According to Abraham's theory, $\lambda_n = 2l/n$ the more nearly, the higher n is (where λ_n = wave-length of oscillation of the nth order, l = length of oscillator). Thus the wave-length of the oscillator in the experiments, from l of receiver = 25·7 cm., comes out at 10·3 cm., the correction for this overtone of the receiver being negligible. The wave-length determined by the interferometer = 10·2 cm. Thus the measurement of wave-length by this method of overtones may be taken as giving accurate results. (2) When the interferometer method is used the receiver must be accurately tuned to vibrate with the same frequency as the oscillator, otherwise the secondary waves radiated from the receiver make the measurements inaccurate. (3) A hard-rubber cylinder supporting a linear oscillator at its middle portion does not appreciably affect its wave-length. (4) The resonant length of a linear thermoelectric receiver is less than that of the linear oscillator. (5) An oscillator 10 cm. long was found to have a wave-length = 20·8 cm. These results agree with Abraham's theory rather than with Macdonald's. (6) A loop of wire used as receiver in order to avoid the effect of radiation from the receiver, gave results which show that a closed circuit under proper conditions may radiate as much energy as an open circuit of the same linear dimensions. T. P. B.

609. *Diffraction of Electric Waves round a perfectly Reflecting Obstacle.* **H. M. Macdonald.** (Roy. Soc., Phil. Trans. 210. pp. 113–144, Feb. 28, 1910.)—The author has previously verified [see Abstract No. 3240 (1904)] that the effect at a point on a perfectly conducting sphere, due to a Hertzian oscillator near to its surface was negligible in comparison with the effect that would have been produced at that point but for the presence of the sphere, when the point is at some distance from the oscillator and the radius of the sphere is large compared with the wave-length of the oscillations. In this paper the effect produced by a Hertzian oscillator placed outside a conducting sphere whose radius is large compared with the wave-length of the oscillations is investigated. From the exceedingly neat mathematical results obtained tables are computed showing how the amplitude of the oscillations diminishes as the distance along the earth's surface from the transmitter is increased. In computing the tables it is assumed that the transmitter and receiver are vertical antennæ, and that the fundamental wave-length is five times the height. The results are given (1) for oscillations of wave-length one-fifth of a mile, corresponding to antennæ 211 ft. high; and (2) for oscillations whose wave-length is one-quarter of a mile, corresponding to antennæ 264 ft. high. In an Appendix proofs are given of several important mathematical theorems required in the investigation. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

610. *Electric Conductivity of Oxidic Insulators and Temperature.* **J. Königsberger.** (Zeitschr. Elektrochem. 16. pp. 162–168, March 1, 1910.)—Examining the researches on insulators like quartz at temperatures up to 1200° C. by F. Horton [see Abstract No. 939 (1906)], M. v. Pirani, and W. v. Siemens (Marquard's mass), Warburg, F. Haber (porcelain), C. Doelter (mix-

tures of oxides), and himself, the author concludes that pure oxides, and also mixtures of oxides which are not of the nature of salts, owe their conductivity to electrons. Oxides like quartz and lime are insulators at ordinary temperature, while iron oxide is an insulator at —180° C. Substances like $KAlSi_3O_8$ offer different resistances with direct and with alternating currents, because they are not quite continuous, showing fissures or pores, and because the Richardson-effect (at the electrodes) and the Wehnelt-effect (in the substance and in the porcelain tube of the furnace) increase the conductivity of the air, particularly with alternating currents. The relation of Rasch and Hinrichsen [see Abstract No. 672 (1908)], $dK/dT = q'/RT^2$, has been known since Clapeyron. H. B.

611. *Conductivity of Electrolytes for High-frequency Oscillations.* **J. v. Geitler.** (Jahrbuch d. Drahtlosen Telegraphie, 3. 3. pp. 294–296, Feb., 1910.) —Let a small electrolytic cell containing dilute sulphuric acid bridge the end of a Lecher-wire system. If sparks pass across a spark-gap, bridging the wires nearer the oscillator, gas is developed in the cell, *i.e.*, there is a continuous-current component passing through it [see Abstract No. 149 (1910)]. It is investigated whether any change takes place in the conductivity of the acid due to the oscillations. The ordinary Kohlrausch method is used. The conductivity of dilute sulphuric acid between Pt electrodes is not sensibly affected by high-frequency electrical oscillations. T. P. B.

612. *Polarisation of Dielectrics in a Steady Field of Force.* **W. M. Thornton.** (Phil. Mag. 19. pp. 390–407, March, 1910. Paper read before the Physical Soc., Jan. 21, 1910.)—An account is given of many experiments on the polarisation of dielectric ellipsoids and cylinders suspended in a steady electric field. By measuring the field intensity, the dimensious of the ellipsoids, and the frequency of the torsional swings with and without the field, the successive values of the apparent dielectric coefficient can be found. The method is practically the same as the one with alternating currents which the author has previously described. In the present experiments the longitudinal component of polarisation reached a higher value than previously recorded. It was found to be independent of the intensity of the field inside the ellipsoid. The substances examined were quartz, fused and crystalline, flint-glass, amber, sulphur, ebonite, rubber, gutta-percha, paraffin wax, resin, and sealing wax. The author gives a novel method of finding the insulativity of the dielectric by measuring the rate of increase of the apparent dielectric coefficient. He points out that the change of polarisation is equivalent to an electric current. The rate of depolarisation when the field was reversed was found to be the same as that of polarisation, and in general it was uniform for several hours. The author suggests that the explanation of this, and of the independence of the field intensity, is to be found in the continued separation of molecular charge by the attraction of the opposite charges on adjacent molecules induced by the application of the field. From a comparison of the present results and those with alternating fields the variation of the apparent dielectric coefficients with frequency can be predicted.

A. R.

ALTERNATING CURRENTS AND MAGNETISM.

613. *Magnetisation of Thin Iron Wire.* **J. A. Veazey.** (Phys. Rev. 30. pp. 180–188, Feb., 1910.)—The sample, a short, annealed iron wire 1 mil in diam. and 6 cm. long, was tested by a magnetometric method, and the max.

induction obtained with a field of about 8 was 18·5. From the smoothness of the B-H curve obtained it is concluded that the elementary magnets, of whatever kind they may be, are less than 1 mil in order of magnitude. G. E. A.

614. *Effect of Temperature on Magnetic Properties of Electrolytic Iron.* **E. M. Terry.** (Phys. Rev. 30. pp. 133–160, Feb., 1910. Electrician, 65. pp. 6–9, April 15, 1910. Abstract.)—The experiments were carried out by the ballistic method on rings of pure electrolytic iron prepared by the Burgess process. The research had three special objects: (1) To test the iron magnetically at different temperatures; (2) to find the best temperature for annealing; (3) to investigate the relation between crystalline structure and magnetic properties. Tests were carried out at all temperatures from that of liquid air up to the critical temperature. The dimensions of the rings were: height 0·4 cm., diameters 8·5 and 8 cm. Special care was taken to guard against leakage between the electric circuits and against oxidation of the rings. For the low-temperature tests Knipp's apparatus was employed, and for high-temperature work an electric furnace of the Heraeus type. It was found that: (1) Freshly prepared electrolytic iron is very hard magnetically; (2) different samples show for low fields marked dissimilarities which disappear upon annealing at 1000° C., but for high fields all samples are quite similar, giving $B = 18{,}600$ for $H = 125$; (3) the retentivity has a maximum in the neighbourhood of room temperature; (4) liquid air produces no permanent hardening; (5) marked softening magnetically occurs at the hydrogen transformation-points; (6) ferro-magnetism reappears on cooling at the same temperature as that at which it disappears on heating, viz., 785° C.; (7) electrolytic iron is in its best magnetic condition when annealed at 1100° C.; (8) electrolytic iron has a slightly lower coercive force and a higher max. permeability than Swedish iron, and on account of its high retentivity has a 60 per cent. greater hysteresis loss. A. D. R.

615. *Magnetism of Copper and its Compounds.* **C. Chéneveau.** (Journ. de Physique, 9. pp. 163–167, Feb., 1910.)—Results are given of determinations of the magnetic susceptibility of pure Cu and some of its compounds by means of Curie and Chéneveau's apparatus. Copper is diamagnetic, the coefficient $K (= \kappa/d) = -0·090 \times 10^{-6}$, where κ is the magnetic susceptibility and d the density. It is found that the surface of the copper is very readily contaminated and the metal is thus rendered apparently paramagnetic. The surface film, which doubtless contains iron impurity, must be removed by repeated washings with sulphuric acid, nitric acid, and water. Specimens of Cu which even after this treatment appear paramagnetic or less diamagnetic than they ought, contain traces of Ni or other magnetic elements in their interior. The oxide of copper, CuO, is paramagnetic ($K = 3·6 \times 10^{-6}$), as are also the various salts of copper which were tested. Mixtures and solutions of copper salts showed no anomalous magnetic properties. A. D. R.

616. *Magnetic and Electrical Properties of Iron-Copper Alloys.* **C. F. Burgess** and **J. Aston.** (Metallurgical and Chem. Engin. 8. pp. 79–81, Feb., 1910. Amer. Electrochem. Soc., Trans. 16. pp. 241–255; Discussion, pp. 255–256, 1909.)—Tests are described on a series of Cu-Fe alloys having a Cu-content of 0 to 7 per cent. and 94 per cent. The apparatus and procedure was the same as that in a previous research [see Abstract No. 446 (1910)]. It is found that the magnetic quality of the iron deteriorates almost in proportion to the added Cu-content, and the alloys give no promise of practical applications. A. D. R.

617. *Production of Intense Magnetic Fields.* **C. Fabry.** (Journ. de Physique, 9. pp. 129–134, Feb., 1910.)—The author discusses the proposal, made by J. Perrin, to obtain intense magnetic fields by means of bobbins without iron, immersed in liquid, which would diminish their resistance to about one-sixth. Such fields would be of value in the study of the Zeeman-effect. The energy W expended in producing a field of strength H increases with the resistance of the wire and with the square of H, and depends also on the space taken by insulation and on the size and shape of the bobbin. Different forms of bobbin are considered, with the view to make W a minimum. The most suitable form would appear to be one with a cylindrical opening, wound with coaxial layers of wire of successively increasing area of section. Such a bobbin would give a field of 100,000 gauss in a cylindrical opening 2 cm. in diam., and would dissipate 100 kw. This would necessitate the evaporation of about 24 litres of liquid air per min. The bobbin would be immersed in a liquid in rapid circulation. H. W. M.

REFERENCES.

618. *Electronic Orbits.* **A. Righi.** (Accad. Lincei, Atti, 18. pp. 301–302, Nov. 7, 1909.)—By the formula given before [Abstract No. 2099 (1909)] the author has calculated the polar co-ordinates of special cases of electronic orbits. One of these is given in a diagram, and to this is added the elliptic orbit produced by the addition of a magnetic field. E. E. F.

619. *Inertia of Moving Electrons.* **W. Heil.** (Ann. d. Physik, 31. 3. pp. 519–546, March 1, 1910.)—A discussion of the most probable value to be derived from the various experiments made for the determination of *e/m* for moving electrons. [See Abstracts Nos. 947 (1906) and 1993 (1908).] E. H. B.

620. *Convection and Röntgen Currents on the Relativity Theory.* **A. Weber.** (Phys. Zeitschr. 11. p. 134, Feb. 15, 1910.)—Derives on the relativity theory, formulæ identical with those obtained by Lorentz on the electron theory. [See Abstract 1990 (1908).] E. H. B.

621. *Electrodeless Discharge.* **K. Fischer.** (Phys. Zeitschr. 11. pp. 39–44, Jan. 15, 1910.)—Experiments were made to decide whether the electrodeless ring-shaped discharge such as occurs in high-frequency apparatus is due to electrostatic or electrodynamic action, and the conclusion is reached that such discharges can be excited by purely electrodynamic actions. J. J. S.

622. *Selenium Cells with Fuller Use of the Light.* **W. S. Gripenberg.** (Phys. Zeitschr. 11. pp. 132–133, Feb. 15, 1910.)—Describes a special form of selenium cell in which the light is more completely used up by its repeated reflections inside glass plates between selenium plates. E. H. B.

623. *Symmetrical Moving Coil.* **C. Féry.** (Comptes Rendus, 150. pp. 524–525, Feb. 28, 1910.)—To do away with any effect due to magnetism in the copper wire composing the coil, the wire is wound symmetrically as regards azimuth, this entailing, however, a diminution in sensitiveness. G. E. A.

624. *Alternating Currents round Iron Cores.* **C. Breitfeld.** (Elektrotechnik u. Maschinenbau, 28. pp. 113–117, Feb. 6, 1910.)—Mathematical article dealing with the iron losses. E. H. B.

625. *Pirani's Method of Measuring Self-inductance.* **J. P. Kuenen.** (Phil. Mag. 19. pp. 439–441, March, 1910.)—In connection with C. H. Lees' paper [see Abstract No. 1748 (1909)] the author gives a simplified proof of the formula used by Pirani. A. R.

626. *Auroræ and Magnetic Storms.* **W. R. Gregg.** (Mount Weather Observatory, Bull. 1. 4. pp. 232–236, 1908.)—The auroræ observed at Mount Weather, Va., on March 27 and May 25, 1908, and the accompanying magnetic disturbances are described. The paper concludes with a summary of recent theories regarding the origin of auroræ. A. D. R.

627. *Magnetic Survey of Saxony.* **O. Göllnitz.** (Meteorolog. Zeitschr. 26. pp. 529–538, Dec., 1909.)—A full account is given of the methods adopted in carrying out the survey. Details are furnished as to the precautions taken, and a table is added exhibiting the magnetic elements at 100 stations. A. D. R.

628. *Problem in Magnetic Induction.* **L. Dunoyer.** (Journ. de Physique, 9. pp. 135–162, Feb., 1910. Paper read before the Soc. française de Physique, March 5, 1909.)—The author discusses the couple exerted on a permanent magnet by a hollow sphere of soft iron placed in its field and magnetised inductively. The couple is deduced mathematically, and experimental verifications are described for particular cases. The result is applied to the action of the two soft iron compensators used in marine compasses. A. D. R.

629. *Magnetic Storm of September 25, 1909.* **P. Müller.** (Meteorolog. Zeitschr. 27. pp. 65–68, Feb., 1910.)—The variations in the declination and in the earth's horizontal and vertical magnetic fields as recorded at Ekaterinburg are detailed and compared with those of previous disturbances. No connection was found between these variations and the movement of the point of brightest illumination in the concomitant auroræ. A. D. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

630. *Preparation and Properties of Pure Boron.* **E. Weintraub.** (Amer. Electrochem. Soc., Trans. 16. pp. 165–184; Discussion, p. 184, 1909. Electrochem. Ind., N.Y. 7. pp. 509–512, Dec., 1909. Abstract.)—By heating boric anhydride with magnesium, Moissan claimed in 1895 to have obtained a boron with 98 per cent of B, which on further fusing with B_2O_3 was said to yield an amorphous powder, light-brown in colour, containing 99 per cent. of B. In gas and electric furnaces the author—in conjunction with E. Kraus and G. Weintraub—could never raise the B percentage above 85. The chief impurity, apart from Mg, Si (reduced by B from quartz tubes), Fe (from the steel balls used in grinding the anhydride)—was a suboxide (B_7O^7), whose oxygen could not directly be determined. The suboxide was estimated by reducing permanganate with the boron; the reduction was smaller than it should be with pure boron. After many attempts, pure boron was prepared by passing the arc discharge through a mixture of boron chloride (vapour) and hydrogen, the latter in excess; the reaction is reversible. Several alternating-current arcs are fed in the same vessel from a high-potential transformer between water-cooled or air-cooled copper electrodes. The boron settles as powder or fused lumps on the walls of the vessel and on the electrodes, and is purified by fusion in a mercury arc or in a high-potential arc in an indifferent gas. The melting-point and sublimation point of boron lie near one another between 2000 and 2500° C. The purest product of 99·5 per cent. did not contain copper, nor hydrogen, but probably some suboxide. It is as hard almost as diamond, but less tough, and has a conchoidal fracture. Its electric resistance is high in the cold, but decreases enormously when hot; boron is easily heated by the current, having a low specific heat. In the presence of carbon the negative temperature-coefficient changes into a positive coefficient. Traces of boron convert carbon from the metalloidal into the "metallised" condition; the metallised carbon of the Gen. Electric Co. (in whose laboratory at West Lynn the research has been conducted) is obtained by depositing carbon from gasolene and heating it to a very high temperature, and it differs from all other carbons in having a positive temperature-coefficient. Boron would not be suitable for lamp filaments, as it coats the walls of the vessel black above 1600° C., but may be utilised as pyrometer or bolometer, as radiotelegraphic detector, as motor starter, &c. Some success has also been achieved in trying to prepare boron by the dissociation of the magnesium boride and of other compounds.

H. B.

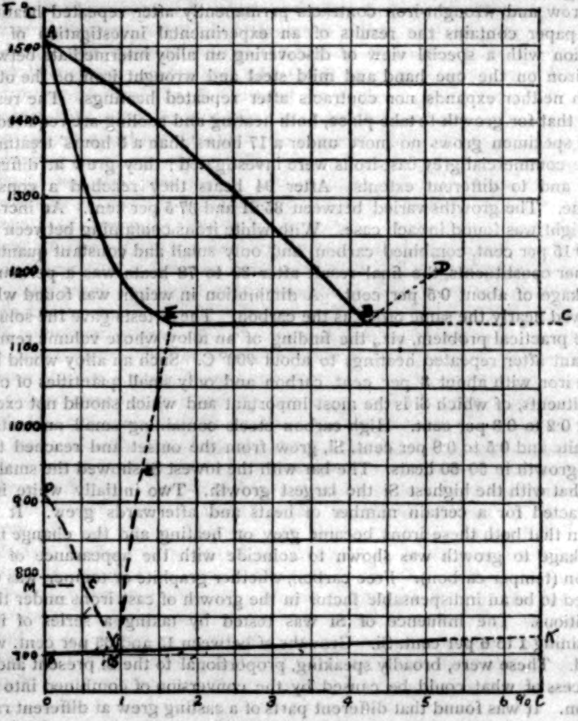
631. *A New Perspective in Industrial Alloys.* **K. Friedrich.** (Metallurgie, 7. pp. 97–99, Feb. 22, 1910.)—Eutectic-forming alloys pass through a pasty stage between the liquidus and eutectic line, and in this state can be kneaded with materials of a higher melting-point and then pressed into any desired shape. Considerable modification of the properties of the alloys can be effected in this manner, giving rise to new industrial materials. The author has experimented successfully on mixing a tin-copper alloy (90 per cent. Sn) with a light-blue glass, and a lead-antimony alloy with iron filings.

By a proper selection of the materials, metallic-looking bodies having low thermal and electrical conductivities, and ornamental materials with a metallic groundwork could be prepared. F. C. A. H. L.

632. *Growth of Cast Irons after Repeated Heatings.* **H. F. Rugan** and **H. C. H. Carpenter.** (Iron and Steel Inst., Journ. 80. pp. 29–125; Discussion and Correspondence, pp. 126–148, 1909. Abstracts in Mech. Eng. 24. pp. 557–560, Oct. 29; 568–570, Nov. 5, and pp. 604–606, Nov. 12, 1909. Metallurgie, 6. pp. 706–716, Nov. 22, 1909.)—Cast-iron annealing ovens 8 ft. in length, which are kept red-hot for prolonged periods, sometimes grow to 9 ft. in length in the course of use. Under the same conditions mild steel does not grow and wrought-iron contracts permanently after repeated heatings. This paper contains the results of an experimental investigation of this question with a special view of discovering an alloy intermediate between cast iron on the one hand and mild steel and wrought iron on the other, which neither expands nor contracts after repeated heatings. The results show that for growth to take place, both heating and cooling are required: a given specimen grows no more under a 17 hours' than a 3 hours' treatment. Three commercial grey cast-irons were investigated; they grew at different rates and to different extents. After 94 heats they reached a constant volume. The growths varied between 35·21 and 37·5 per cent. An increase of weight was found in each case. With white irons containing between 4·08 and 0·15 per cent. combined carbon, and only small and constant quantities of other constituents, the final result after 39 to 78 heats was a permanent shrinkage of about 0·5 per cent. A diminution in weight was found which followed nearly the same order as the carbon. These tests gave the solution of the practical problem, viz., the finding of an alloy whose volume remains constant after repeated heatings to about 900° C. Such an alloy would be a white iron with about 3 per cent. carbon and only small quantities of other constituents, of which Si is the most important and which should not exceed about 0·2 to 0·3 per cent. High-carbon steels containing small amounts of graphite and 0·5 to 0·8 per cent. Si, grew from the outset and reached their max. growth in 50–60 heats. The bar with the lowest Si showed the smallest, and that with the highest Si the largest growth. Two initially white irons contracted for a certain number of heats and afterwards grew. It was shown that both these irons became grey on heating, and the change from shrinkage to growth was shown to coincide with the appearance of free carbon (temper carbon). Free carbon, whether graphite or temper was thus proved to be an indispensable factor in the growth of cast irons under these conditions. The influence of Si was tested by taking a series of irons containing 1 to 6 per cent. Si. Growths of between 15 and 63 per cent. were found. These were, broadly speaking, proportional to the Si present and far in excess of what could be caused by the conversion of combined into free carbon. It was found that different parts of a casting grew at different rates, and it was obvious from this that gases played an important *rôle* in the growth. The gradual penetration of gases into the alloys during growth was studied microscopically. Large amounts of gas are dissolved at certain stages. Graphite is displaced from its original position, the spaces left are oxidised and numerous small holes are formed. Fe-Si alloys containing 0·65 to 2·71 per cent. Si and no graphite, were shown not to grow appreciably after repeated heatings. By heating an iron-silicon-carbon alloy containing 6·14 per cent. Si *in vacuo* no growth was obtained, proving that the growth was due to the penetration of gases. The author's results are compared with

those of A. E. Outerbridge, Jr., and a short account is also given of the agencies at work in the growth of grey cast-irons on repeated heating. [See also Abstract No. 792B (1904).] C. O. B.

638. *Theory of the Melting and Fusion Processes of Iron-Carbon Alloys.* N. Gutowsky. (Metallurgie, 6. pp. 781–786, Nov. 22, and pp. 787–743, Dec. 8, 1909.)—Some of the iron-carbon alloys have been reinvestigated, and the results have led the author to modify Carpenter and Keeling's diagram to the form shown in the Fig., in which the full lines are the author's, while the lines of dashes are Heyn's and the dotted lines are undetermined lines. The liquidus was determined by taking cooling curves of eleven alloys containing from 0·577 to 4·94 per cent. carbon, but an adequate idea of the solidus can only be obtained from cooling-curves obtained under ideal conditions. Accordingly the solidus was determined by heating small samples under a layer of $BaCl_2$, KCl, or NaCl, to definite temperatures for periods of 7 minutes and then quickly quenching in water at 6° C. Microscopic examination was then applied to determine those samples in which fusion had just commenced. In this way an accurate determination of the temperatures at which steels begin to melt was obtained, and these temperatures are of the utmost



practical importance, because they represent the point at which steels begin to burn. Application of Tammann's method to the arrests on the eutectic line indicates that 1·7 per cent. carbon represents the limit of the eutectic line, this view being confirmed by the fact that a slowly cooled 1·76 per cent. carbon steel, and a 2 per cent. carbon alloy heated for a long time at 1140° C. both show eutectic structure. The diagram differs from Carpenter and Keeling's, inasmuch as the liquidus AB is less convex and the solidus AE follows lower temperatures. Cementation experiments showed that at temperatures of 1100° C. carburisation is slow on account of the slowness of diffusion of Fe_3C. The experiments showed that the carbon-content reached by the cementation of wrought iron, and the combined carbon obtained by heating white iron, lie on the curve S E, which is a continuation of Heyn's curve Se. Experiments carried out on the fusion and solidification of white and grey cast-irons showed that at the eutectic temperature white iron is converted into a mixture of elementary carbon (temper carbon and graphite) and solid solution E (1·7 per cent. C), so that white iron passes into grey iron just before melting. Since both white and grey irons enrich themselves in the solid solution E before fusion, the rate of heating must influence the temperature at which fusion begins. Actual experiments have shown that this temperature is lowered by slow heating. The paper is illustrated by nine diagrams and twenty-five photomicrographs. F. C. A. H. L.

634. *Change of Equivalent Conductance of Ions with Temperature.* **J. Johnston.** (Amer. Chem. Soc., Journ. 31. pp. 1010–1020, Sept., 1909. Contribution from the Research Lab., Mass. Inst. of Technology, No. 44.)—It was found that a linear relationship existed between the logarithms of the fluidity and of the molecular conductivity at infinite dilution of a series of salts in aqueous solutions at temperatures from 0° to 150°. Assuming that the mobilities of $\overset{+}{K}$ and $\overset{-}{Cl}$ remain approximately equal at the higher temperatures a similar relationship was deduced for the equivalent conductance (mobility) of the separate ions. This can be expressed by the formula, $\log \Lambda = m \log \phi + \log h_1$ or $\Lambda = h_1 \phi^m$, where $\phi =$ fluidity of water and m and h_1 are constants. The extreme range of m was from 0·81 to 1·08 only for the different ions, showing that the conductance and fluidity are nearly proportional, the fluctuations due to the special properties of the ions being of secondary importance. Adopting the known relationship between fluidity and temperature the variations of conductance with temperature can be expressed by the formula, $\log \Lambda = p \log \theta - \log h$ or $\Lambda = \theta^p / h$, θ being the temperature measured from $-48·25°$ C. Similar relationships were found to hold for the observations of Dutoit and Duperthuis (Journ. Chim. Phys. 6. p. 726, 1908) on the conductivity of sodium iodide in organic solvents.

T. M. L.

635. *Electrical Conductivity of Ferric Sulphate Solutions.* **R. C. Wells.** (Amer. Chem. Soc., Journ. 31. pp. 1027–1035, Sept., 1909.)—At low dilutions the conductivity of ferric sulphate solutions is abnormally low, at high dilutions abnormally high. Upon dilution a "basic salt" is precipitated, the rate of hydrolysis increasing enormously with rise of temperature and with increasing dilution. By direct measurement at low dilutions and by extrapolation at high dilutions the conductivity of the ferric sulphate solutions before precipitation begins can be determined. Values given for 0°, 25°, and 30° indicate that hydrolysis begins at a dilution of a few litres, the first stage being instantaneous, but the second stage, which involves the formation and precipitation of the "basic salt," proceeding with velocity slow enough to be readily measured. T. M. L.

636. *Condition of Substances in Absolute Sulphuric Acid.* II. **G. Oddo** and **E. Scandola.** (Zeitschr. Phys. Chem. 66. 2. pp. 138–152, March 30, 1909. Universitätslaborat. f. allgem. Chemie, Pavia, Dec. 17, 1908.)—A controversial paper in reply to Hantzsch [see Abstract No. 1335 (1908)]. Carefully dried organic bases, and the acid sulphates of ammonium, sodium, and potassium gave molecular weights about one-half the normal values, as already stated by the author, and not the $\frac{2}{3}$ values recorded by Hantzsch. Water gave an intermediate molecular weight, about $\frac{7}{11}$ the normal value. The higher values obtained by Hantzsch appear to be due to some different action produced by the first addition of solute to the sulphuric acid.

T. M. L.

637. *Gas Generation in Accumulators.* **E. Rumpf.** (Zeitschr. Elektrochem. 16. pp. 163–165, March 1, 1910.)—The author places a small accumulator of Varta in a Hofmann gas-voltameter and inserts another voltameter (Pt electrodes in sulphuric acid) in the same circuit, which is closed by pouring acid into the accumulator. The first gas evolved is displaced air. Oxygen generation sets in slowly; the generation of hydrogen is first much smaller, but becomes much more energetic finally when the p.d. of the cell suddenly rises. The accumulator always yields less gas, however, than the voltameter. Hydrogen is evidently occluded by the lead, and there was still absorption of hydrogen after continuing the charge for a month. This hydrogen improves the capacity of the cell. H. B.

638. *Electrolytic Preparation of Calcium.* **F. C. Frary** and **W. L. Badger.** (Amer. Electrochem. Soc., Trans. 16. pp. 185–195, 1909.)—The authors review the literature on the subject and describe experiments made with crucibles resembling those of Tucker and Whitney, who poured fused calcium chloride over a bottom plate of fluorspar and cooled the kathode which was slowly raised. Fresh chloride may be added to the fused electrolyte without danger of spattering, if the chloride is previously heated in an iron crucible over Bunsen burners. The "anode" effect is particularly discussed; when a critical density is exceeded, the anode becomes surrounded by gas, the current passes into a series of small arcs, and the spheroidal state is noticed. The melting-points of mixtures of lime with calcium chloride were determined. H. B.

REFERENCES.

639. *Ternary Alloys of Cu, Ag, Au; Cr, Mn; Fe, Co, Ni; Pd, Pt.* **E. Jänecke.** (Zeitschr. Phys. Chem. 67. 6. pp. 668–688, Oct. 12, 1909.)—A theoretical paper on the types of diagrams to be expected from ternary alloys of the above metals, which is too involved for short abstract. Of the 45 binary alloys of these metals 30 have been already investigated, and the author divides the 120 ternary alloys into eight groups, according to the nature of the binary series entering into the ternary alloy.

F. C. A. H. L.

640. *Limiting Concentration at the Boundary of Two Solvents.* **E. H. Riesenfeld** and **E. Zermelo.** (Phys. Zeitschr. 10. pp. 958–961, Dec. 1, 1909.)—Mathematical.